Audio Menu

Operation Manual

Covers Welch Allyn AM232 Manual Audiometer

Grason-Stadler

GSI 17 Audiometer

Service Manual

GSI
Grason-Stadler
A Welch Allyn Company

Grason-Stadler, Inc.
1 Westchester Drive
Milford, NH 03055-3056
Telephone: 603-672-0470
Fax: 603-672-0487

Warranty

We, Grason-Stadler, Inc. warrant that this product is free from defects in material and workmanship and, when properly installed and used, will perform in accordance with applicable specifications. If within one year after original shipment it is found not to meet this standard, it will be repaired, or at our option, replaced at no charge except for transportation costs, when returned to an authorized Grason-Stadler service facility. If field service is requested, there will be no charge for labor or material, however, there will be a charge for travel expense at the service center's current rate.

NOTE

Changes in the product not approved in writing by Grason-Stadler shall void this warranty. Grason-Stadler shall not be liable for any indirect, special or consequential damages, even if notice has been given in advance of the possibility of such damages.

THIS WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO, ANY IMPLIED WARRANTY OF MERCHANTABILITY OF **FITNESS FOR A PARTICULAR** ***PURPOSE.***

GSI
Grason-Stadler
A Welch Allyn Company

Grason-Stadler, Inc.
1 Westchester Drive
Milford, NH 03055-3056
Telephone: 603-672-0470
Fax: 603-672-0487

Service Manual 1717-0110, Rev. 4
Printed January, 1991 (#1)
Printed April, 1991 (#2)
Printed January, 1992 (#3)
Printed January, 1994 (#4)

Table of Contents

Warranty i
Table of Contents iii
Warning vii
Key to Symbols Used on Schematics viii
Foreword ix

SECTION 1 - PRODUCT SPECIFICATIONS

1.1 Catalog Listings 1
1.2 Standards 1
1.3 Test Stimulus 1
1.4 Output Hearing Level Controi 2
1.5 Signal to Noise Ratio 2
1.6 Tone Switch 2
1.7 Stimulus 3
1.8 Transducers 3
1.9 Front Panel Controls/Rear Panel Connectors 3
1.10 Power and Power Line 5
1.11 Battery Pack Voltage 5
1.12 Environmental Conditions 5
1.13 Mechanical Dimensions 6
1.14 Material Used in Manufacture _ _ _ _ _ _ _ _ _ _ _ _ 6
1.15 Leakage Test 6
1.16 Headband Static Force 6
1.17 Earphone Cushion Attenuation 6
1.18 Accessories 7

SECTION 2 - FUNCTIONAL DESCRIPTION

Figure 2-1: Connectors, Controls, Indicators . . . 8
2.1 Front Panel Controls and Indicators 9
2.2 Rear Panel Connectors and Controls 10
2.3 General Operation of Controls 10
2.4 Power Up Initialization 10
2.5 Sleep Mode 11

SECTION 3 - ROUTINE MAINTENANCE

3.1 Earphone Cords 13
3.2 Hum and Random Noise 13
3.3 Distortion and Frequency Shift 13
3.4 Special Messages 14
3.4.1 CAL 14
3.4.2 Exx 14

SECTION 4 - CALIBRATION

4.1	Quick Reference Calibration	16
	Figure 4-1: Quick Reference Calibration Control;	17
	Figure 4-2: Access to Calibration Controls	18
	Table 4-1: Calibration Reference Threshold;	19
4.2	Calibration Mode Operation	19
4.2.1	Cal/Normal Switch	19
4.2.2	Calibration Mode Dip Switches	19
4.3	Calibration Mode Entry	20
4.4	Mode Initialization	21
4.5	Earphone SPL Calibration Mode	21
4.5.1	Tone Type Switch	21
4.5.2	Routing Switch	21
4.5.3	Frequency Selector'	22
4.5.4	Present Bar	22
4.5.5	**HL Dial**	22
4.5.6	Extended Range **Pushbutton**	22
4.5.7	Response Switch	23
4.5.8	**HL Display**	23
4.5.9	Response LED	23
4.5.10	Stimulus ON	23
4.5.11	Low Battery Segment	23
4.5.12	"+" LCD Segment	23
4.6	Calibration Mode Exit	24
4.7	Calibration Data Storage and Validation	24
4.8	Calibration Mode Dip Switch	25
4.8.1	Dip Switch S4	25
4.8.2	Dip Switch S3	25
4.8.3	Dip Switch S2	27
4.8.4	Dip Switch S1	27
4.9	Selection of the Diagnostic Mode	28
4.9.1	Hardware Diagnostic Test (DO)	29
4.9.2	Pushbutton Diagnostic Test (D1)	31
4.9.3	Display Diagnostic Test (D2)	33
4.9.4	A/D Converter Diagnostic Test (D3)	34
4.9.5	Attenuator Maximum Output Level Calibration (D4)	38

SECTION 5 - DISASSEMBLY

	Figure 5-1: Disassembly	42
5.1	Disassembly Instructions	43
5.2	Parts Numbers	43
5.3	Accessories and Replacement Parts	44

SECTION 6 - TROUBLESHOOTING

6.1	Troubleshooting Using the Hardware Diagnostic Mode (DO)	45
	Figure 6-1: Diagnostic Mode Controls and Functions	46
6.2	Output Related Troubleshooting Symptoms	48
	Figure 6-2: Block Diagram of Amplifier Signal Flow	48
6.3	Left or Right Amplifier Troubleshooting Symptoms	49

SECTION 6 - TROUBLESHOOTING (Continued)

	Figure 6-3: Block Diagram of Attenuator Signal Flow	50
6.4	Attenuator Troubleshooting Hints	50
	Table 6-1: Attenuator Circuit Test Check	51
6.5	Oscillator Troubleshooting Hints	52
6.6	Troubleshooting the Processor (U503)	52
6.7	Power Supply Related Problems	53
6.8	Troubleshooting the Display	54
6.9	Switch Related Failures	54
6.10	Error Messages	54A

SECTION 7 - BLOCK DIAGRAM

	Figure 7-1: Block Diagram	56
7.1	Analog Circuit	57
7.2	Digital Circuit	57

SECTION 8 - AUDIOMETER MODULE

8.1	General Notes	61
8.2	Microcomputer (U503)	61
8.3	EPROM (U505)	62
8.4	Timer (U505)	62
8.5	Polled Controls	62
8.6	Input/Output (I/O) Port Designations	63
8.7	Display (LCD)	66
8.8	Output Routing	67
8.9	Power Supply	67
8.10	Oscillator	67
8.11	Attenuator and 10 dB Range Extender	68
8.12	Potentiometer Adjustment Procedures	68
8.13	Suggested Repair Parts	69
	Figure 8-1: Audiometer Board, Component Layout #1.	71
	Figure 8-1: Audiometer Board, Component Layout #2.	72
	Figure 8-2: Audiometer Board, Schematic #1	73
	Figure 8-2: Audiometer Board, Schematic #2	74
	Figure 8-2: Audiometer Board, Schematic #3	75
	Figure 8-2: Audiometer Board, Schematic #4	76
8.14	Audiometer Board Parts List	77

SECTION 9 - POWER MODULE

9.1	Update	81
9.2	For Specific Serial Number	81
	Figure 9-1: Power Module Schematic	83
	Figure 9-2: Power Module/Cords	84

SECTION 10 - BATTERY OPTION

Figure 10-1: Battery Pack Installation 86
10.1 Description 87
10.2 Battery Pack Installation 87
Figure 10-2: Battery Power Connection 88
10.3 NiCad Battery Operation 89
10.4 Alkaline Battery Installation/Operation 90
Figure 10-3: NiCad Battery Pack 91
10.5 NiCad Battery Assembly Parts List 92
10.6 Battery Board Functional Description 92
Figure 10-4: Battery Charger Board Schematic 93
10.7 Battery/Charge Board Parts List 94

APPENDIX A

Figure A-1: Component Layout Test Circuit . . . . . A 3
Figure A-2: Schematic and Parts List Test Circuit . . A 4

WARNING

The GSI 17 is designed to be used with a hospital grade outlet. Injury to personnel or damage to equipment can result when a three-prong or two-prong adapter is connected between the GSI 17 power plug and an AC outlet or extension cord. **Additionally, the GSI 17 is equipped with a specific power transformer which should not be interchanged with any other transformer or supply.**

The above symbol indicates the location of a service adjustment part and is intended for service personnel use only. The GSI 17 is a specifically calibrated audiometer and the periodic service and adjustments which the instrument may require should be done **only by an authorized Grason-Stadler service technician.**

Key to Symbols Used on Schematics

Flow Arrow — defines current flow on schematics

RMS — Voltages which are designated in this symbol are AC Rms levels

DC — Voltages which are designated in this symbol are DC levels

Pk to Pk — Voltages which are designated in this symbol are Peak to Peak

T.P. — Test Point, male pin which is generally at a convenient point on a board for quick scope or voltmeter connections

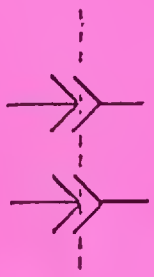
Ground — Ground symbol which when shown with a letter designates a ground structure that returns separately to main instrument ground

P1 — Goldfinger — Terminal designation for all gold plated finger connections at bottom of all plug-in boards

WT — Wire Tie — Male printed circuit board connector which will have jumper to complete connection.

JP — Jumper — Jumper connects two Wire Ties (WT's)

On-Board Connection — Any line on a schematic which is terminated with an X and a designation means that next point it goes is on the same PC board, but elsewhere on one of the schematics



Connector — Generally shows a connection which leaves the board. When a dotted line passes thru several it means they share a common designation, i.e., P1

Schematic Sheet Number — Signal flow continued on this sheet.

FOREWORD

GENERAL SERVICE INFORMATION

Operating, check-out procedures, trouble-shooting hints, etc., can be found in the Instruction Manual (1717-0100). Repair and/or bench testing of GSI 17 Audiometers should only be performed by trained personnel. The following instructions are provided primarily for use by persons who are skilled in the repair of electronic equipment.

CMOS HANDLING PRECAUTIONS

Many of the integrated circuits on the P.C. boards are CMOS and NMOS type.

CAUTION

Failure to observe the following precautions whenever a circuit board or an integrated-circuit package is handled can result in damage to the GSI 17.

a. Place instrument and parts on a grounded, conductive work surface.

b. Ground yourself (with a strap having about 1 M ohm resistance).

c. Ground the frame of any test instrument or soldering iron to be used.

d. If any circuit boards are to be stored or transported, enclose them in conductive (anti-static) envelopes.

SECTION 1

Product Specifications

1.1 CATALOG LISTINGS

1717-9700 GSI 17 Audiometer, AC Power (USA)
1717-9710 GSI 17 Audiometer, AC Power and Battery (USA)
1717-9705 GSI 17 Audiometer, AC Power (Export)
1717-9715 GSI 17 Audiometer, AC Power and Battery (Export)

1.2 STANDARDS

This unit is a single channel, pure tone screening audiometer. It is equipped with pure tone stimulus signals, and air conduction transducers (TDH39 Earphones). This instrument meets ANSI S3.6 and IEC 645 Type 4 Audiometer Standards.

The GSI 17 is designed to meet current revisions of the following standards and specifications for audiometers:

ANSI S3.6
IEC 645
ISO 389
IEC 601

1.3 TEST STIMULUS

PURE TONE SPECIFICATIONS

A pure tone is the only stimulus source for this audiometer.

DISCRETE FREQUENCIES

125, 250, **500, 750, 1000, 1500, 2000, 3000, 4000,** 6000, 8000 Hz

FREQUENCY ACCURACY

< ±3%

TOTAL HARMONIC DISTORTION (FROM 125 Hz TO 4000 Hz, MEASURED ACOUSTICALLY)

Frequency	Test HL	
125 Hz	60 dB	< 2%
1000 Hz	100 dB	< 2%
3000 Hz	100 dB	< 2%

1.4 OUTPUT HEARING LEVEL CONTROL

CALIBRATED IN dB HL

MEASURED IN INCREMENTS OF 5 dB

RANGES

125 Hz	-10 to **50** dB HL
500 to **6000** Hz	-10 to 90 dB HL
250 and 8000 Hz	-10 to 70 dB HL

Additionally A "+10 dB" Extended Range Switch, which extends maximum HL at all frequencies by 10 dB.

ACCURACY OF ALL SETTINGS OF HEARING LEVEL CONTROL:

125 to 4000 Hz	±3 dB
6000 to 8000 Hz	±5 dB

1.5 SIGNAL TO NOISE RATIO (IN 1/3 OCTAVE)

>70 dB measured acoustically in dB HL

1.6 TONE SWITCH

This electronic switch turns the stimulus signal ON/OFF with minimal audible distortion.

MODES

Normal State:	Stimulus OFF
Activated State:	Stimulus ON

RISE/FALL TIME

20-50 ms
Measured at the -1 dB and -20 dB points on the signal envelope.

ON/OFF RATIO

With the Tone Switch OFF, the output will be at least -10 dB below standard reference equivalent threshold for any 1/3 octave band with HL setting of 60 dB or below.

ABOVE 60 dB HL SETTING

>70 dB

CROSS CHANNEL LEAKAGE

At HL settings of 70 dB or greater, unwanted signals in the non-test earphone shall be at least 70 dB below the tone in the test earphone.

1.7 STIMULUS TYPES

Continuous Tone
Continuous FM Tone
Pulsed Tone

SIGNAL FORMAT

Continuous - Signal steady as long as Present Bar is depressed.

Pulsed -

Pulsed Rate: 2.5 Pulses/sec
Pulse rate is synchronized to the "Present Bar" so that the first and last pulse will have 200 ms on time.

DUTY CYCLE

50%

RISE/FALL TIME

20-50 ms

ON/OFF RATIO (BETWEEN PULSES)

>20 dB

FREQUENCY MODULATION

FM Rate: 5 Hz
FM Deviation: ±5%

1.8 TRANSDUCERS

HEADSET

TDH39 Earphones with 60 ohm impedance

1.9 FRONT PANEL CONTROLS AND REAR PANEL CONNECTORS

FRONT PANEL

CONTROLS

Frequency Selection
HL Select
Mode Selector (Pulsed/Steady/FM)
Routing (Left/Right)
Present Bar
Power Switch
"+10 dB Push-Button

INDICATORS:

Power ON/OFF
Frequency Selector
dB HL - LCD
Left/Right Earphone
Pulsed/Steady/FM
Subject Response - LED
"Battery Low" (when applicable, i.e. Battery Option purchased) - LCD
Tone ON - LED
Extended Range - LCD

REAR PANEL CONNECTORS

Left and Right Earphone - 1/4" Phone Jack
Subject Response Switch - 1/4" Phone Jack
Power Cord - 5 Pin DIN

LEFT AND RIGHT EARPHONE JACKS (J4 & J5)

Pin#	Function	Output Voltage	Impedance
Tip	Phone High	25 u VRMS to 2.5 VRMS (max)	130 ohms
Sleeve	Phone Low	0 Volts	0 ohms

SUBJECT SWITCH (J7)

Pin&	Function	Output Voltage	Impedance
Tip	Switch High	+5 Vdc	47 K ohms
Sleeve	Switch Low	0 Volts	0 ohms

POWER INPUT (J1)

Pin #	Name	Battery Power No Power Module Attached	Power Module Connected w/NiCad Battery Installed	Power Module Connected w/Alkaline Battery Installed	Power Module Only No Battery
J1-1	VSUP	NC	NC	NC	t9.0 to 16.0
J1-2	CHASGND	PROTECTIVE GND	PROTECTIVE GND	PROTECTIVE GND	PROTECTIVE GND
J1-3	CGND	0 (REF)	0 (REF)	0 (REF)	0 (REF)
J1-4	BAT/LINE	2.6 to 3.0	3.7 to 4.3	3.7 to 4.3	4.3 to 5.1
J1-5	VBAT	+7.3 to 9.0	+7.0 to 9.0	7.0 to 13.5	to 13.5

All values listed are in Volts DC

1.10 POWER AND POWER LINE

POWER RATING

9 Watts power module operated while simultaneously charging battery.
0.6 Watts battery power

OPERATING MODES

Power Line (Mains)

Battery - Rechargeable (NiCad) or Non-Rechargeable (Alkaline)

LINE (MAINS) VOLTAGE

115 V or 220 V

LINE (MAINS) VOLTAGE VARIATION

±10%

LINE (MAINS) FREQUENCY RANGE

50-60 Hz

LINE (MAINS) FREQUENCY VARIATION

±5%

1.11 BATTERY PACK VOLTAGE

BATTERY VOLTAGE OPERATING RANGE

7.0 v to 9.0 v

BATTERY PACK TYPICAL OPERATING LIFE

NiCad:	22 Hours
Alkaline:	45 Hours

1.12 ENVIRONMENTAL CONDITIONS

OPERATING TEMPERATURE RANGE

15 to 40 Degrees Celsius

SHELF TEMPERATURE RANGE

Power Module Operated:	-40 to 60 Degrees Celsius
Battery Operated:	-40 to 40 Degrees Celsius

RELATIVE HUMIDITY RANGE

5% to 90%

1.13 MECHANICAL DIMENSIONS

Weight: 5.6 lbs (2.53 Kg)
Weight of Battery Pack: 1.5 lbs (0.68 Kg)
Size: 13.25"W x 14"D x 3.75"H
(33.66 cm x 35.56 cm x 9.53 cm)

1.14 MATERIALS USED IN MANUFACTURE

GSI 17 Case Assembly - GE Cycolac T
Battery Option Case Assembly - GE Cycolac T
Power Module Case Assembly - Noryl SE - 100J
(Flame Retardant)

1.15 LEAKAGE TEST (AC) CONNECTED/SAFETY TEST

Leakage Current - <25 uamps

High Voltage Breakdown	115 V operation	>3000 v
	220 V operation	>4000 v

1.16 HEADBAND STATIC FORCE

1.6 to 2.0 pounds when earcups are 5.7 inches apart. Measured with distance center of headband to center of earphones equal to 5 inches.

1.17 EARPHONE CUSHION ATTENUATION

Frequency (Hz)	(dB)enuation
125	6.5
250	4.5
500	7.0
750	10.0
1000	15.5
1500	18.5
2000	26.0
3000	30.5
400	33.0
6000	27.0
8000	24.5

1.18 ACCESSORIES

Supplied	Catalog Numbers
Test Headset (TDH39)	8000-0175
Audiogram Forms (1 pad of 50)	1717-9600
Instruction Manual	1717-0100
Battery Pack Assembly (used with 1717-9710, 1717-9715 models only)	1717-2010
AC Power Cord, one of the following:	
120 v (US)	8000-0240
220 V (Euro plug)	8000-0241
240 V (UK)	8000-0242
220 V (Generic) GSI 17's with serial numbers below # 0856 require a different power module. See Section 9, Power Module, for details.	8000-0250

Optional	Catalog Numbers
Response Handswitch	7874-0156
Patch Cord, 2 Conductor	4202-0505
Audiocups	8000-0155
Battery Pack Assembly Battery Pack includes GSI supplied NiCad Battery. May also be used with six (6), Size C, Alkaline Batteries (not included)	1717-2010
Replacement NiCad Battery	8410-0060

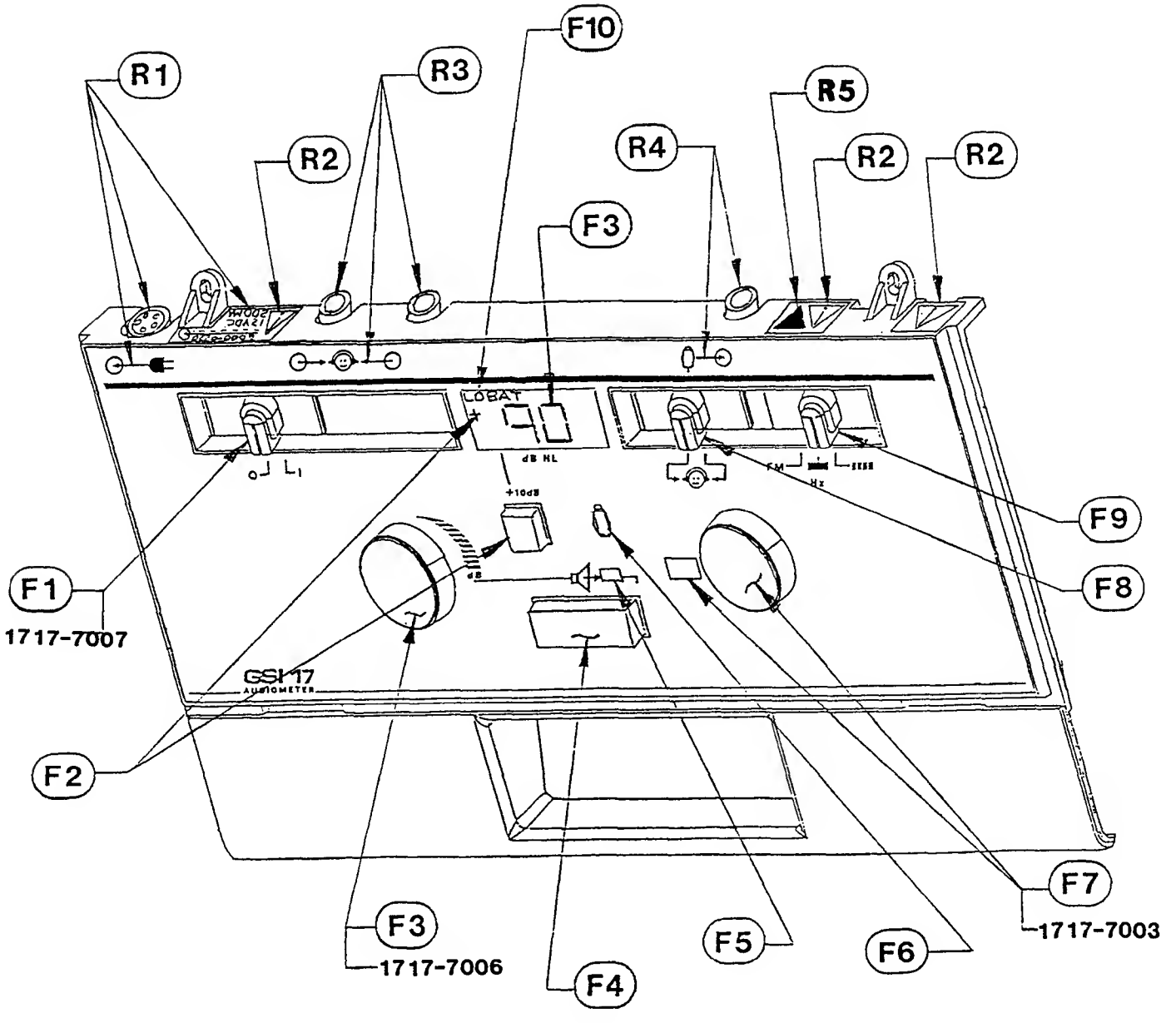


Figure 2-1: CONNECTORS, CONTROLS, INDICATORS

SECTION 2

Functional Description

This section of the Service Manual is used to describe the Connectors, Controls, and Indicators of the GSI 17. Refer to Figure 2-1 for the layout and positioning of all Connectors, Controls, and Indicators.

2.1 THE FRONT PANEL CONTROLS AND INDICATORS (FIGURE 2-1)

F1 - Power switch and indicators for ON (|) and OFF (0).

F2 - Range extension pushbutton allows operator to increase the stimulus intensity 10 dB above the standard maximum HL at any frequency - its operation is indicated by the "+" being lit on the LCD.

F3 - HL control for setting stimulus intensity level. Level indicated on LCD.

F4 - Present Bar for stimulus presentation.

F5 - Loudspeaker in operation as such. Actual presentation indicated by illuminated LED.

F6 - Subject response indicator LED shows the operator that the test subject has pressed the handswitch button.

F7 - Frequency control for setting stimulus frequency. Frequency indicated in window adjacent to control.

F8 - Routing switch for routing the stimulus signal to the left or right earphone. Left or right indicated by illustration of **subject.**

F9 - Tone type switch for setting the stimulus tone type.
FM = warble tone
= steady tone
--- = pulsed tone

F10 - Low battery indicator to alert the operator when the batteries have a limited operating time available (recharge or replace batteries soon, depending on whether NiCad or alkaline batteries are used).

2.2 REAR PANEL CONNECTORS AND INDICATORS

R1 - Power input jack with front panel indication of position and rear panel indication of input power specifications.

R2 - Attention, consult accompanying documents.

R3 - Earphone output jacks with front panel indication of left and right phone provided by illustration of subject.

R4 - Subject response switch input jack with front panel indication of position.

R5 - Calibration switch indication.

2.3 GENERAL OPERATION OF CONTROLS

All controls are valid at all times once the power up initialization is complete, except for special cases as indicated in this document and for the Extended Range Pushbutton which depends on the HL selection. When the Extended Range is invalid there will be no indication given to the operator other than the absence of the "+" LCD segment.

All polled controls are checked every 12 msec for a change in state. All operations of all controls are debounced for 12 msec before processing.

The Extended Range pushbutton operates by a push ON, push OFF manner. The Present Bar and Response Switch operate by a press and hold manner (except in the Calibration and Diagnostic modes where the Present Bar is push ON, push OFF).

When a press and hold type control is operated all other controls are still active.

When the operation of a control is being processed the processing of all other controls is delayed until the first operation is completed.

2.4 POWER UP INITIALIZATION

When the power switch is set to the ON position the instrument will go through the following initialization process:

All internal and external hardware components of the microprocessor system will be initialized for the required type of operation.

All LEDs and LCD segments will be turned on to indicate that the power up initialization is in progress.

The RAM will be tested using a read after write verification process. After each location is tested its value will be initialized to 0. If an error is detected, an error code will be displayed on the HL display and the instrument will halt.

The EPROM will be tested by reading the complete EPROM to generate a checksum which will be compared to a checksum stored in the EPROM. This test will be performed without using any of the RAM. If an error is detected an error code will be displayed on the HL display and the instrument will halt.

The operating mode of the instrument will be determined by the position of the Cal/Normal Switch and the four Cal Option Dip Switches. Refer to Sections 3 for the Calibration and Diagnostic Mode initialization. The remaining initialization process will be performed for the Normal Mode.

The current HL selection and the HL display will be initialized to 0 HL. All other controls and displays will be initialized to their currently selected positions. All analog hardware will be initialized according to these selections.

After initialization, the instrument will remain idle with all controls active.

2.5 SLEEP MODE

The GSI 17 has a mode which is designed to lengthen battery life. When the unit has been left on, under battery power, without operation for more than 5 minutes, the GSI 17 will enter the Sleep Mode. It is important to emphasize that this mode exists only when the unit is operating with batteries, and is not available when connected to mains (ac) power.

If a period of 5 minutes has elapsed since any control was operated (front panel, internal, external) the unit will go to "sleep", thus drawing minirnal current.

Prior to entering the Sleep Mode, the display will be updated to indicate 3 dashes " - - - " to advise the operator of its sleep mode status. It will also disable the voltage converter (+7 to -7 Volt) which will disable much of the analog circuitry. When the unit enters the sleep mode, all transducers will be disconnected, the channel will turn OFF and the CPU will enter a STOP state which will halt its operation.

The Sleep Mode is exited, and normal operation resumed, when either the Present Bar or power switch are toggled.

SECTION 3

Routine Maintenance

3.1 EARPHONE CORDS

With extended use, earphone cords tend to fray internally at the junctions with both earphone and audiometer connectors. This fraying will ultimately either decrease the signal level in the associated earphone or cause signals to be intermittent as the cord is flexed.

To check for either condition, set the audiometer frequency control (F7) to 1000 or 2000 Hz, set HL control (F3) at a comfortable audible level, press the Present Bar (F4) and flex earphone cord next to plug at both ends, listening for intermittent signal, abrupt changes in signal level, or a scratchy sound superimposed over the signal that coincides with the flexing of the cord. The presence of any of these three conditions signifies that the cord should be replaced.

Repeat the test for the other earphone.

3.2 HUM AND RANDOM NOISE

This test can be made during the check for attenuator noise. With the instrument set on 1000 Hz, move the HL control (F2) from 0 to 60 dB and listen for low-frequency hum (60 to 120 Hz) and random noise (hiss or low rushing sound) at all attenuator levels. Some audible random noise at levels above 60 dB is permissible. Below 60 dB however, only the signal should be audible. Any of these noises can be confused with the signal by naive subjects and affect the accuracy of the audiogram. Schedule the audiometer for immediate service if any of these symptoms are detected.

3.3 DISTORTION AND FREQUENCY SHIFT

This check is most easily performed by listening to the output of the GSI 17 through the earphones while presenting all 11 frequencies at a loud, but not uncomfortable, level (70 to 80 dBHL for normal ears).

Listen for rattling, rasping or distortion in the tones presented. Listen also to ascertain that signal frequencies change when the Frequency Selector (F5) is moved to a new position. If distortion is heard in one earphone but not in the other, the chances are high that the earphone is at fault and should be replaced. In any case, the audiometer should be immediately scheduled for maintenance.

3.4 SPECIAL MESSAGES

The GSI 17 is a microprocessor-controlled instrument which performs a self check each time the instrument is turned on (the self check does not occur when the instrument is "awakened" from sleep mode). Certain messages will be displayed to the operator on the front panel LCD if any error in the instrument operation is detected. These messages are described below.

3.4.1 CAL

When a transducer or frequency is selected which has a calibration error (i.e. right earphone at 2000 Hz), the word "CAL" will be displayed to the operator. The audiometer will not function at this frequency with this transducer, so that no invalid results can be recorded. The word "CAL" will be displayed as long as the "problem" transducer and frequency are selected. If the calibration error is an isolated situation, changing either the frequency or the transducer (i.e. left earphone or 3000 Hz) will restore normal instrument function.

As is the case with any instrument malfunction, a certified service technician should be contacted immediately. Remember to make note of the combination of transducer and frequency which resulted in the "CAL" message.

3.4.2 Exx

When an error code consisting of an "E" and a 2-digit number (xx, = number) appears on the audiometer's display, a system error has been detected. The GSI 17 will enter a "lockout" mode which will not permit the instrument to operate. The specific error code will remain on the display for several seconds, then the instrument will shut itself down completely. Should an Exx appear on the LCD, take the following steps:

a. Power down, then power up again. This error could be only a temporary failure and may never appear again. However, should the Exx message reappear, proceed to steps b. and c.

b. Record the numbers that appear on the display.

c. Contact your certified service representative and give them the specific numbers you have recorded.

SECTION 4

Calibration

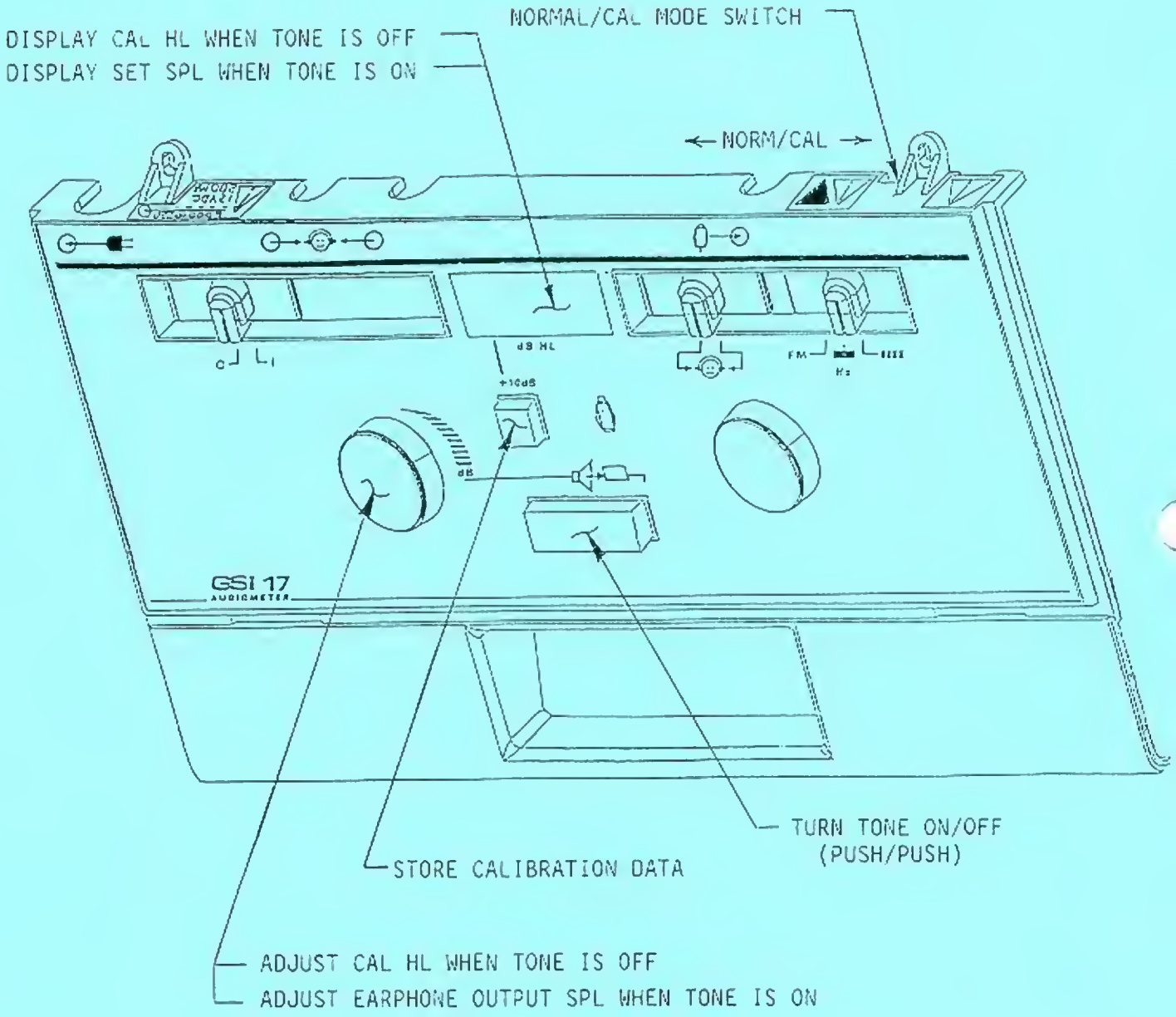

DISPLAY CAL HL WHEN TONE IS OFF
DISPLAY SET SPL WHEN TONE IS ON
NORMAL/CAL MODE SWITCH
← NORM/CAL →
GSI 17
AUDIOMETER
TURN TONE ON/OFF
(PUSH/PUSH)
STORE CALIBRATION DATA
ADJUST CAL HL WHEN TONE IS OFF
ADJUST EARPHONE OUTPUT SPL WHEN TONE IS ON

Figure 4-1: QUICK REFERENCE CALIBRATION CONTROLS

4.1 QUICK REFERENCE CALIBRATION

a. Select Calibration Mode using Cal/Norm Switch.

b. Select Frequency and Reference HL for calibration.

c. Select Earphone Routing (L or R).

d. Turn Tone ON using Present Bar.

NOTE: Display will update to the ANSI SPL required for proper calibration - subtract or add microphone corrections as necessary.

e. Adjust Output Level to the required SPL using the HL Dial.

f. Store data using the +10 dB Range Extender Pushbutton (+) LCD Segment will illuminate to indicate storage of data.

g. Repeat for all frequencies.

h. Repeat for opposite earphone.

i. Return Cal Switch to NORM position.

NOTE: If A CAL ERROR occurs or the MICROPROCESSOR HAS BEEN REPLACED, the following steps should be performed:

a. Short JP1 pins 1 and 2 then power-up for 2-3 seconds. Power-down and remove jumper. (See Troubleshooting, Section 6.6).

b. Load Default Data. (See Dip Switch 4, this section).

c. Battery low/shut down calibration. (See Diagnostic Mode (D3), this section).

d. Attenuator maximum output level calibration. (See Diagnostic Mode (D4), this section).

e. Proceed with Transducer Calibration.

Most important (a, c and d).

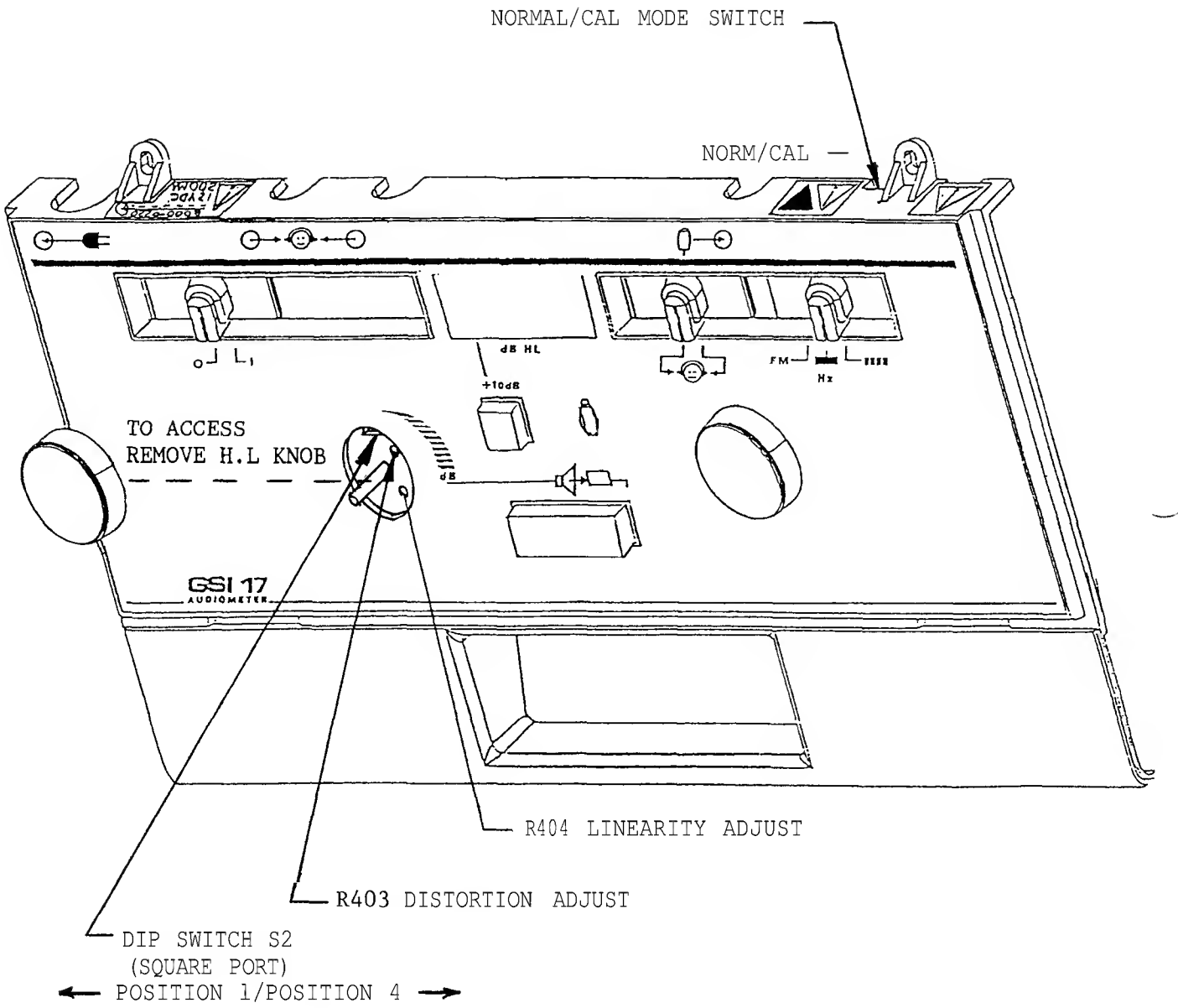


Figure 4-2: ACCESS TO CALIBRATION CONTROLS

Table 4-1: CALIBRATION REFERENCE THRESHOLDS

Freq (Hz)	**125**	**250**	**500**	**750**	**1000**	1500	2000	3000	4000	6000	8000
dB	45.0	25.5	11.5	8.0	7.0	6.5	9.0	10.0	9.5	15.5	13.0

Standard Reference Threshold Levels re: 20 uPa for Telephonics TDH39-P earphones as measured on the National Bureau of Standards 9-A coupler. Reference ANSI S3.6-1989, ISO 389-1975 Standards.

4.2 CALIBRATION MODE OPERATION

The Calibration Mode is used to perform the transducer calibration. This calibration information is used during the Normal Mode to determine the correct attenuator position to produce the required SPL for the selected HL. The Calibration Mode consists of two modes.

The Custom SPL Selection Mode allows the selection of customized SPL values for alternate transducers. The Transducer SPL Calibration Mode is used to calibrate the sound pressure level (SPL) of each stimulus for each transducer.

4.2 .1 CAL/NORMAL SWITCH

This switch is used to select the operating mode of the instrument. The Calibration Mode is entered by setting this switch to the CAL position while Dip Switch S1 is in the OFF position. The Calibration Mode is exited by setting this switch to the NORMAL position.

4.2.2 CALIBRATION MODE DIP SWITCHES

(See "Calibration Mode Dip Switch In-Depth Description" later in this section.)

These Dip Switches select various options of the Calibration Mode. They are read to determine the selected options when the Calibration Mode is entered.

Switch	Function	OFF (down)	ON (up)
s4	**Default Data** Loads the default Calibration data into EEPROM when the Calibration Mode is entered.	**OFF**	**Load**
s3	**Custom SPL Mode** Enables the selection of user specified SPL values during the transducer calibration procedure when set to the Custom position.	**GSI**	**Custom**
s2	**Not used**	N/A	N/A
S1	**Diagnostic Mode** Selects the Calibration Mode when the Cal/Normal Switch is set to the Cal position if this switch is in the OFF position.	OFF	**Selected**

The status of Dip Switches #4 and #1 are read only when the Calibration Mode is entered. Dip Switch #3 is read and a change in its position is processed if the Calibration Mode was entered with this switch in the ON position. Then the switch cay be returned to the OFF position without exiting the Calibration Mode.

4.3 CALIBRATION MODE ENTRY

The Calibration Mode can be entered via the Cal/Normal Switch at any time except during the power up initialization phase or when a stimulus is being presented. In these cases the Cal Mode will be entered when the initialization is complete or the stimulus turned off. The indication that the instrument is in the Calibration Mode will be the non integer value in the format of xx.x on the HL Display.

During the Calibration Mode initialization process all controls will be inactive.

When the Calibration Mode is entered, all LCD segments except the low battery segment will be turned off. If Dip Switch S4 is set to the ON position the process of loading the default calibration data will be started and the LCD display will have all segments except the low battery segment turned on to indicate that the default data and checksum are being loaded. When completed, the display will reinitialize to all segments except the low battery segment will be off.

The EEPROM will then be tested by reading the complete EEPROM to generate a checksum which will be compared to a checksum stored in the EEPROM. If an error is found the word "CAL " will be flashed on the HL display and the initialization process will continue.

Dip Switch **#3** will be checked to determine which CAL mode is to be initialized. If in the OFF position the transducer SPL calibration mode is selected, and if in the ON position, the Custom SPL selection mode will be selected.

4.4 MODE INITIALIZATION

When the transducer SPL Calibration Mode is selected the instrument will be initialized as follows:

Tone Type = Current selection
Frequency = Current selection
Channel = OFF
Calibration HL = 10 dB below the nonextended HL limit for. the current transducer and frequency
Transducer SPL = Calibration HL + Current RTL
+10 dB Pad = Out
Transducer Routing = Current selection
HL Display = Current custom SPL level stored in EEPROM
Response LED = OFF
Stimulus On LED = OFF
Low Battery Segment = Current state
"+" Segment = OFF

4.5 EARPHONE SPL CALIBRATION MODE

This Calibration Mode is used to calibrate the SPL for each stimulus for each transducer. This is done by adjusting the selected transducer output SPL level to the specified value displayed on the HL display. This SPL value is the sum of the calibration HL level and the Reference Threshold Level (RTL) for the current transducer and frequency. The RTL may be either the standard RTL value or a custom RTL value depending on the position of Dip Switch #3 when the Calibration Mode was entered.

The transducer SPL calibration data is stored in EEPROM by transducer and stimulus.

4.5 .1 TONE TYPE SWITCH

This switch operates as in the Normal Mode to select the Tone Type of the stimulus.

4.5.2 ROUTING SWITCH

This switch operates as in the Normal Mode to select the transducer to be calibrated. All transducers must be calibrated and they can be calibrated in any sequence.

4.5.3 FREQUENCY SELECTOR

This control operates as in the Normal Mode to select the frequency to be calibrated. All frequencies must be calibrated and they can be calibrated in any sequence.

4.5.4 PRESENT BAR

The Present Bar controls the presentation of the stimulus. It operates in a push ON/push OFF manner. If the Present Bar is operated while the stimulus is off, the stimulus will be turned on and remain on until the Present Bar is operated a second time. The stimulus will actually be turned ON or OFF when the Present Bar is pressed.

4.5.5 HL DIAL

1. This control performs the dual function of selecting the HL level at which the calibration is being performed and of adjusting the output level of the transducer.

2. While the stimulus is off, the HL selector will select the Calibration HL level (Cal HL). The level will be adjusted up by 5 dB for each clockwise step of the selector and down by 5 dB for each counter clockwise step. For each change in the Calibration HL level the transducer output level (attenuator position) will be recalculated using the current calibration data stored in the EEPROM. The allowable range of the calibration HL will be from the nonextended (+10 dB range) maximum HL limit to 20 dB below the limit. Operation of the selector to select levels outside of this range are invalid. When this occurs the level will default to the limit and the HL display will be flashed.

3. While the stimulus is on, the HL selector (dial) will adjust the transducer output level to allow the SPL level to be adjusted to the required SPL level on the sound level meter. The output level will be adjusted up by 0.5 dB for each clockwise step of the selector and down by 0.5 dB for each counter clockwise step. The output level is changed according to the HL selector by directly setting the attenuator position. Operation of the HL dial to select positions outside of the instrument range will be invalid. The attenuator position will be adjusted within the limits and the displayed SPL value on the HL display will be flashed.

4.5.6 EXTENDED RANGE PUSHBUTTON

This pushbutton is used to store the transducer SPL calibration data into EEPROM. After the calibration data is successfully stored, the EEPROM checksum will be updated and the Patient Response LED will be turned on for 2 seconds. If the calibration data can not be stored successfully, the word "CAL"' will be flashed on the HL display and the previously displayed SPL value

will be restored. If this error occurs the calibration process can be continued for other frequencies.

4.5.7 RESPONSE SWITCH

This switch is not used during the transducer SPL Calibration Mode. Operations of the switch are not processed.

4.5.8 HL DISPLAY

a. This display performs the dual function displaying the Calibration HL level and the SPL to which the transducer output level must be adjusted for correct calibration.

b. When the stimulus is OFF, the HL display will show the current Calibration HL level in dB HL in the format xx.0 using digits 1, 2 and 3.

c. When the stimulus is ON, the HL display will show the required transducer output level in dB SPL in the format xxx.x using digits 1, 2, 3 and 4. This value is the sum of the current Calibration HL and the Reference Threshold Level (RTL) for the current transducer and frequency and does not indicate correction for the sound level meter frequency response.

4.5.9 RESPONSE LED

This LED is used to indicate the correct storage of calibration data in the EEPROM when the Extended Range Pushbutton is operated. This LED is normally OFF and will be turned ON for 2 seconds after the calibration data has been stored and verified. If the data is not stored correctly the LED will remain off and the word "CAL" will be flashed on the HL display and then the previously displayed transducer output level SPL value will be restored.

4.5.10 STIMULUS ON LED

This LED is used to indicate the ON or OFF state of the stimulus. While the stimulus is OFF the LED will be OFF and will be turned ON while the stimulus is ON.

4.5.11 LOW BATTERY SEGMENT

This LCD segment will indicate a low battery voltage condition as in the Normal Mode (ie: LOW BAT).

4.5.12 "+" LCD SEGMENT

This segment is not used during the transducer SPL Calibration Mode and will remain off.

4.6 CALIBRATION MODE EXIT

The Calibration Mode can be exited back to the Normal Mode via the Cal/Normal Switch at any time except for when default calibration data is being loaded. In this case the Calibration Mode is exited when the loading of default data is complete.

When the Calibration Mode is exited the instrument will initialize for the Normal Mode based on the current state of the controls, as in the power up initialization.

4.7 CALIBRATION DATA STORAGE AND VALIDATION

All calibration data or other data which must be retained when the instrument is turned off is stored in EEPROM. This data consists of the following:

- Transducer SPL calibration data by transducer and frequency
- Custom RTL values by transducer type
- Custom RTL vs. GSI RTL calibration selection
- Attenuator 2.5V maximum output level limit by stimulus
- EEPROM checksum

The data is stored using a triple redundancy method (the same as in the GSI 16 and GSI **33** control Processor). In this method each data bit is stored **3** times, once in each of **3** different blocks within the EEPROM with a different format in each of the **3** blocks. When a specific data bit is required the appropriate location in each of the **3** blocks is read and decoded. For the data to be valid the value from 2 of the **3** blocks must match. This method will allow for the detection of data errors and the correction of some errors.

If a calibration data read error is detected the frequency which would use the data will not be available for testing in the Normal Mode by forcing the stimulus off and not processing operations of the present bar. The instrument will continue to function and all other frequencies for which no calibration data error exists will be available. A data error will be indicated by displaying the word "CAL" on the HL display until the frequency or transducer is changed to a new selection that has no data error.

In addition to the triple redundancy validation used for individual pieces of data, a 2 byte checksum will be stored in the EEPROM which will allow the validity of all data stored in the EEPROM to be determined. This check will be performed when the Calibration Mode is entered.

4.8 CALIBRATION MODE DIP SWITCH IN-DEPTH DESCRIPTION

The Dip Switches, located beneath the HL dial, will be described in reverse numerical order. The reason for this is that they are in the order in which we anticipate the frequency of usage will be.

4.8.1 DIP SWITCH S4

NOTE : IF DEFAULT DATA IS LOADED, DIAGNOSTIC MODE D4 PROCEDURE MUST BE PERFORMED!

DEFAULT CALIBRATION DATA

All calibration data or other data stored in the EEPROM will have a corresponding set of default data stored in EEPROM which may be used to initialize the EEPROM. This is performed by entering the Calibration Mode with Dip Switch #4 in the ON position.

Transducer SPL calibration data:
This default data is typical of transducers supplied with the instrument.

Custom RTL values:
This default data consists of the standard GSI RTL values for the transducer types supplied with the instrument.

Custom RTL vs. GSI RTL selection status:
This will default to the GSI RTL selection.

Attenuator 2.5 V maximum output level limit:
This will default to an attenuator limit for each stimulus.

Checksum:
The EEPROM checksum is calculated using the contents of the EEPROM after all default data has been stored.

4.8.2 DIP SWITCH S3

CUSTOM RTL SELECTION MODE

This mode enables selection of the displayed custom RTL values only and does not allow adjustment of the transducer's output level.

If the user desires to use alternate transducers, this mode would normally be selected first to set the custom RTL values and then the earphone SPL calibration would be performed. When the Calibration Mode is entered with Dip Switch #3 in the ON position, Dip Switch #3 can be used to switch from the custom SPL selection to the transducer SPL mode while remaining in the Calibration Mode.

The custom RTL values are stored in EEPROM by transducer type. The RTL values for a left transducer and a right transducer must be the same. The HL limits are directly affected by any changes in the RTL values.

MODE INITIALIZATION

When the Custom RTL selection mode is selected the instrument will be initialized as follows:

Tone Type = Current selection
Frequency = Current selection
Channel = Off
+10 dB Pad = Out
Transducer Routing = Current selection
HL Display = Current RTL level stored in EEPROM
Response LED = Off
Stimulus On LED = Off
Low Battery Segment = Current state
"+" Segment = Off

HL SELECTOR

The HL Selector is used to select the custom RTL level. The level can be adjusted up by 0.5 dB for each clockwise step and down by 0.5 dB for each counter clockwise step. The transducer output level (attenuator position) does not follow changes to the custom RTL value.

The allowable range of the custom RTL value is **±63.5** dB SPL. Operation of the knob to select levels outside of this range will not be allowed. If this occurs, the displayed custom RTL value will remain the same and will flash temporarily.

FREQUENCY SELECTOR

Selects the frequency for which the custom RTL is to be selected.

ROUTING SWITCH

Inactive in this mode.

EXTENDED RANGE PUSHBUTTON

This pushbutton is used to store the custom RTL value into EEPROM. After the RTL value is successfully stored the EEPROM checksum will be updated and the Patient Response LED will be turned on for 2 seconds. If the SPL value can not be stored successfully, the word "CAL" will be flashed on the HL display and then the previously displayed RTL value will be restored. If this error occurs, the calibration process may still be continued for other frequencies.

DIP SWITCH #3 OPERATION WHILE IN CAL MODE

The Cal Option Dip Switch #3 is used to switch from the custom RTL calibration mode to the transducer SPL calibration mode.

OTHER CONTROLS

All other controls, except the Cal/Normal Switch and Dip Switch #3, are inactive during this mode. Operations of all other controls will not be processed.

HL DISPLAY

The HL display is used to display the selected custom RTL value in the format xx.x. using digits 1 through 3 of the HL display. Negative values will be displayed with a minus sign.

LOW BATTERY SEGMENT

This LCD segment indicates a low battery voltage condition as in the Normal Mode.

PATIENT RESPONSE LED

This LED indicates when the custom RTL value has been stored successfully in the EEPROM by turning on for 2 seconds.

OTHER DISPLAYS

All other LEDs and LCD segments are not used and will remain off.

4.8.3 DIP SWITCH S2

NOT USED - Exception when in Diagnostic Mode (Dip Switch #1)

4.8.4 DIP SWITCH S1

DIAGNOSTIC MODE

The Diagnostic Mode provides direct control over the hardware components which may not be available in the Normal or Calibration Modes. This mode is provided to facilitate testing and debugging of the board or instrument.

The Diagnostic Mode consists of four diagnostic tests and one calibration mode as follows:

Hardware Diagnostic test
Pushbutton Diagnostic test
Display Diagnostic test
A/D Diagnostic test
Attenuator Maximum Output Limit calibration

The features of the Diagnostic Mode are controlled manually from the front panel.

4.9 SELECTION OF THE DIAGNOSTIC MODE

CAL/NORMAL SWITCH

This switch is used to select the operating mode of the instrument. The Diagnostic Mode is entered by setting this switch to the Cal position while Cal Option Dip Switch #1 is in the on position. When Dip Switch #1 is on, Dip Switches #2 through #4 select the diagnostic test to be performed. The Diagnostic Mode is exited by setting the Cal/Normal switch back to the Normal position.

DIP SWITCHES

When the Diagnostic Mode is entered the functions assigned to the CAL Option Dip Switches, (except Switch #1), are redefined to allow the selection of the desired diagnostic test.

The Dip Switches will be read only when the Calibration Mode is entered. To switch between diagnostic tests it is necessary to exit the Calibration Mode, reset the Dip Switches to select the new test and then re-enter the Calibration Mode.

Switch #	Function	OFF (down)	ON (up)
S1	Diagnostic Mode Enters the Diagnostic Mode when the Cal/Normal Switch is set to Cal.	OFF	Selected

s2, S3, & s4 These switches are used to select the diagnostic test to be performed when the Diagnostic Mode is entered as follows:

	Switch Setting				Diagnostic Test
	S1	s2	s3	s4	Selected
D0	ON	OFF	OFF	OFF	Hardware Diagnostic
D1	ON	OFF	OFF	ON	Pushbutton Diagnostic
D2	ON	OFF	ON	OFF	Display Diagnostic
D3	ON	OFF	ON	ON	A/D Diagnostic
D4	ON	ON	OFF	OFF	Attenuator Maximum Output Level Cal
D0	ON	ON	OFF	ON	Hardware Diagnostic
D0	ON	ON	ON	OFF	Hardware Diagnostic
D0	ON	ON	ON	ON	Hardware Diagnostic

**The Diagnostic Mode is entered via the Cal/Normal Switch at any time except during the power up initialization phase. If selected via the switch, the Diagnostic Mode will be entered when the initialization is complete or the stimulus turned off.

When switched into the Diagnostic Mode the HL display will display a code to indicate which diagnostic test is being selected. The codes are as follows:

"D0 " = Hardware Diagnostic Test
"D1" = Pushbutton Diagnostic Test
"D2 " = Display Diagnostic Test
"D3 " = A/D Diagnostic Test
"D4" = Attenuator Maximum Output Level Cal

The code will display for 2 seconds and then the instrument will initialize for the selected test. During this time all controls will be disabled.

4.9.1 HARDWARE DIAGNOSTIC TEST (DO)

TEST DESCRIPTION

This diagnostic test provides direct and independent control of the following hardware blocks:

Oscillator Frequency
Stimulus Multiplexer
Attenuator Position
+10 dB Pad Position
Transducer Routing

Each hardware block is controlled independent of all other blocks i.e., selecting an oscillator frequency will not change the attenuator position.

TEST INITIALIZATION

When switched into the hardware diagnostic test, the instrument will be initialized as follows:

Tone Type = Current Selection
Frequency = Current Selection
Stimulus Mux = Oscillator or External input based on current frequency knob position
Channel = OFF
Attenuator position = 255
Response LED = OFF
Stimulus On LED = OFF
Low Battery Segment = Current State
"+" Segment = OFF

TONE TYPE SWITCH

This switch selects the Steady, FM or Pulsed Tone type just as in the Normal Mode. The Steady and Pulsed Tone types will apply to any stimulus (internal oscillator or external stimulus) being used. The FM Tone type will always FM the internal oscillator, even if the external stimulus is selected.

ROUTING SWITCH

This switch selects the transducer to which the stimulus is routed just as in the Normal Mode.

FREQUENCY KNOB

The frequency knob is used to select the internal oscillator frequency and to control the stimulus multiplexer. When 125 Hz to 8000 Hz are selected on the knob, the internal oscillator is set for the frequency selected and the stimulus mux is set to the internal oscillator. When the unlabeled position on the knob between 125 Hz and 8000 Hz is selected the stimulus mux will be set to select the external stimulus input. The internal oscillator will remain at the last selected frequency. An external signal of 1 V RMS can be applied to J2 on the board.

PRESENT BAR

The Present Bar controls the presentation of the stimulus. It operates in a push on/push off manner so, if it is operated (pressed and released) when the stimulus is off the stimulus will be presented and will remain on until the Present Bar is operated a second time. The +10 dB pad will not be affected by turning the stimulus ON or OFF.

HL SELECTOR

This knob is used to directly set the attenuator position. The position will be adjusted by +0.5 dB (1 step) for each clockwise step of the knob and by -0.5 dB for each counter clockwise step of the knob. The allowable range of the attenuator position will be from 0 to 255. When either of these limits are reached the attenuator position will not change and the HL display will be flashed.

EXTENDED RANGE PUSHBUTTON

This pushbutton is used to control the position of the +10 dB pad. When this pushbutton is operated the +10 dB pad will be selected and the "+" LCD segment will turn on to indicate that the pad is in. When the pushbutton is operated a second time, the pad will be removed and the "+" segment turned off. **The attenuator will not be compensated for the pad position.**

RESPONSE SWITCH

This switch is not used during the hardware diagnostic test and all operations will be ignored.

HL DISPLAY

This display is used to display the the attenuator position in the range of 0 to 255 as selected by the HL selector. It will be

displayed in a right justified, integer format on digits 1, 2 and 3.

RESPONSE LED

This LED is not used during the hardware diagnostic test and will remain OFF.

STIMULUS ON LED

This LED is used to indicate when the stimulus is being presented. The LED is OFF when the stimulus is not being presented and ON when it is being presented.

LOW BATTERY SEGMENT

This LCD segment indicates a low battery voltage condition.

"+" SEGMENT

This LCD segment indicates the position of the +10 dB pad. When the pad is "in" the segment will be ON and when the pad is "Out" the segment will be OFF.

4.9.2 PUSHBUTTON DIAGNOSTIC TEST (D1)

TEST DESCRIPTION

This test provides a means of testing all controls, except for the Cal/Normal Switch, for proper operation when manually operated. While in this test, the operation of any control will display the keycode of the new position of the control on the HL display. This keycode will be displayed until another control is operated.

TEST INITIALIZATION

When switched into the pushbutton diagnostic test, the instrument will be initialized as follows:

Tone Type = Current selection
Frequency = Current selection
Stimulus Mux = Current position
Channel = OFF
Attenuator position = 255
+10 dB Pad = Out
Transducer Routing = None
HL Display = Displays "D1" for 2 seconds and then blanks
Response LED = OFF
Stimulus On LED = OFF
Low Battery Segment = Current state
"+" Segment = OFF

DESCRIPTION OF CONTROLS

In this test, the controls except the Cal/Normal Switch are not used to select functions, but are only operated for testing purposes.

HL DISPLAY

This display is used to display the keycodes as controls are operated. The keycode will display on digits 1 and 2.

LOW BATTERY SEGMENT

This LCD segment will indicate a low battery voltage condition.

ALL OTHER DISPLAYS

All other seqments and LEDs are not used during this test and will remain OFF.

DISPLAY CODES FOR PUSHBUTTON/SWITCH SELECTIONS

Control	Key Code
Left	02
Right	03
Pulsed	04
FM	05
Steady	06
125 Hz	07
250 Hz	08
500 Hz	09
750 Hz	10
1000 Hz	11
1500 Hz	12
2000 Hz	13
3000 Hz	14
4000 Hz	15
6000 Hz	16
8000 Hz	17
Freq Position 12	18
Response Switch	
Press	20
Release	21
Extended Range	22
Present Bar	
Press	23
Release	24
HL Knob	25
Dip Switch #1	31
Dip Switch #2	32
Dip Switch #3	33
Dip Switch #4	34

4.9.3 DISPLAY DIAGNOSTIC TEST (D2)

TEST DESCRIPTION

This test provides a means of visually testing the operation of all LCD segments and LEDS. When the test is selected, the code "D2 " will be displayed on the HL display for 2 seconds. All segments and LEDs will then be blanked for 2 seconds, after which all segments and LEDs will be turned on for 2 seconds to allow inspection for any displays which do not turn on. All segments/LEDs will then be turned on individually for 1 second in a left to right, top to bottom sequence to allow for inspection of any shorts between segments. After all segments/LEDs have been sequenced through all segments/LEDs will be turned back on to indicate the completion of the test.

During this test the low battery voltage monitoring will not be performed since the display is not available to indicate a low battery condition.

TEST INITIALIZATION

When switched into the display diagnostic test, the instrument will be initialized as follows:

Tone Type = Current selection
Frequency = Current selection
Stimulus Mux = Current position
Channel = OFF
Attenuator position = 255
+10 dB Pad = Out
Transducer Routing = None
HL Display = Displays "D2" for 2 seconds and then the display test starts
Response LED = OFF
Stimulus On LED = OFF
Low Battery Segment = Current state
"+" Segment = OFF

DESCRIPTION OF CONTROLS

All controls except the Cal/Normal switch are inactive during this diagnostic test. Operations of all other controls will be ignored.

DESCRIPTION OF DISPLAYS

All LCD segments and LEDs are tested during this diagnostic test. There are no parameter or status information displayed on the displays.

4.9.4 A/D CONVERTER DIAGNOSTIC TEST (D3)

TEST DESCRIPTION

This test will provide a means to test the A/D converter channel used to measure the battery voltage. When this test is selected the A/D input will be sampled every msec and the converted value displayed on the HL display.

During this test the low battery voltage monitoring will not be performed since the A/D converter is not available to measure the battery voltage.

TEST INITIALIZATION

When switched into the A/D Converter diagnostic test, the instrument will be initialized as follows:

Tone Type = Current selection
Frequency = Current selection
Stimulus Mux = Current position
Channel = OFF
Attenuator Position = 255
+10 dB Pad = Out
Transducer Routing = None
HL Display = Displays "D1" for 2 seconds and then blanks
Response LED = OFF
Stimulus On LED = OFF
Low Battery Segment = Current State
"+" Segment = OFF

DESCRIPTION OF CONTROLS

All controls except the Cal/Normal switch and Extended Range Pushbutton are inactive during this diagnostic test. Operations of all other controls will be ignored.

EXTENDED RANGE PUSHBUTTON

This pushbutton is used to store the A/D values in the EEPROM for "LO Bat" detection and instrument "shutdown". Instrument "shutdown" will occur when the battery voltage is too low to safely operate the GSI 17 circuitry.

When the Extended Range Pushbutton is pressed the first time, the A/D value is stored as the battery low warning limit in the EEPROM. The Patient Response LED will be turned ON and "L1" will be displayed on the HL display for 2 seconds. Then the previously displayed A/D value will be restored. If the A/D value can not be stored properly, the word "CAL" will be flashed on the HL display and the previously displayed value will be restored. The A/D value for battery low warning limit must be stored successfully before allowing the next press of Extended Range Pushbutton to store the battery shutdown limit. After the A/D value is stored properly the EEPROM checksum will be updated.

When the Extended Range Pushbutton is pressed the second time, the A/D value is stored as the battery shutdown limit in the EEPROM. The Patient Response LED will be turned on and "L2" will be displayed on the HL display for 2 seconds. The previously displayed value will then be restored. Once the A/D value for the battery shutdown limit is stored successfully, the Extended Range Pushbutton will be inactive. After the A/D value is stored properly, the EEPROM checksum will be updated.

DESCRIPTION OF DISPLAYS

HL DISPLAY

The HL Display is used to display the A/D value in the range of 0 to 255 in a right justified, integer format on digits 1, 2 and 3.

ALL OTHER DISPLAYS

All other LCD segments and LEDs are not used in the diagnostic test and will remain off.

ADJUSTMENT PROCEDURE: BATTERY LOW/SHUTDOWN CALIBRATION

USING - TEST CIRCUIT

Equipment Required - Test Circuit (see Appendix A) DVM

1. Connect test circuit to GSI 17 power input.
2. Connect Power Module to test circuit.
3. Connect DVM to Audiometer Module TP100 (LOW) and TP102 (HIGH).
4. Power up the GSI 17 and adjust test circuit potentiometer to maximum voltage out.
5. Enter Diagnostic Mode (D3)
   a) Place Dip Switch S2 positions 1, 3, 4 to the ON position.
   b) Place the Cal/Norm Switch to the Cal position.
6. The GSI 17 Display will momentarily display D3, then will update to a converted A/D value. Adjust the test circuit potentiometer voltage to obtain 7.30 Vdc (±50 mV) on the DVM. Store the new A/D value in memory by pressing the +10 dB Range Extender button. The display will momentarily display L1 indicating proper storage of data into memory. (It is important that the +10 dB button is pressed only once. If L2 is displayed exit Cal Mode, return to Step 5 and repeat procedure.)

7. Adjust the test circuit potentiometer voltage to 7.0 Vdc (±50 mV). Store this A/D value into memory by pressing the +10 dB Range Extender button. The display will momentarily display L2 indicating proper storage of data in memory.

8. Adjust the test circuit potentiometer for maximum voltage out. Place Dip Switch S2 all positions to OFF, and place S6 Cal/Norm Switch to the Normal Mode position.

9. Slowly decrease the test circuit voltage until the LOW BAT indicator is displayed. This should occur between 7.25 and 7.35 Vdc. Continue decreasing the input voltage. The display should blank from 6.95 to 7.05 Vdc. **NOTE: To clear the LOW BAT indication the unit must be returned to full power and the power switch toggled.**

After completing calibration and verification checks remove the test circuit and proceed with calibration of transducers.

USING A DC VOLTAGE SUPPLY

In order to calibrate using a DC voltage supply, the BAT/LINE circuit must indicate BAT, simulating that the GSI 17 is being operated by battery power. This can be performed using the Resistor Diode combination shown in Figure 4-3.

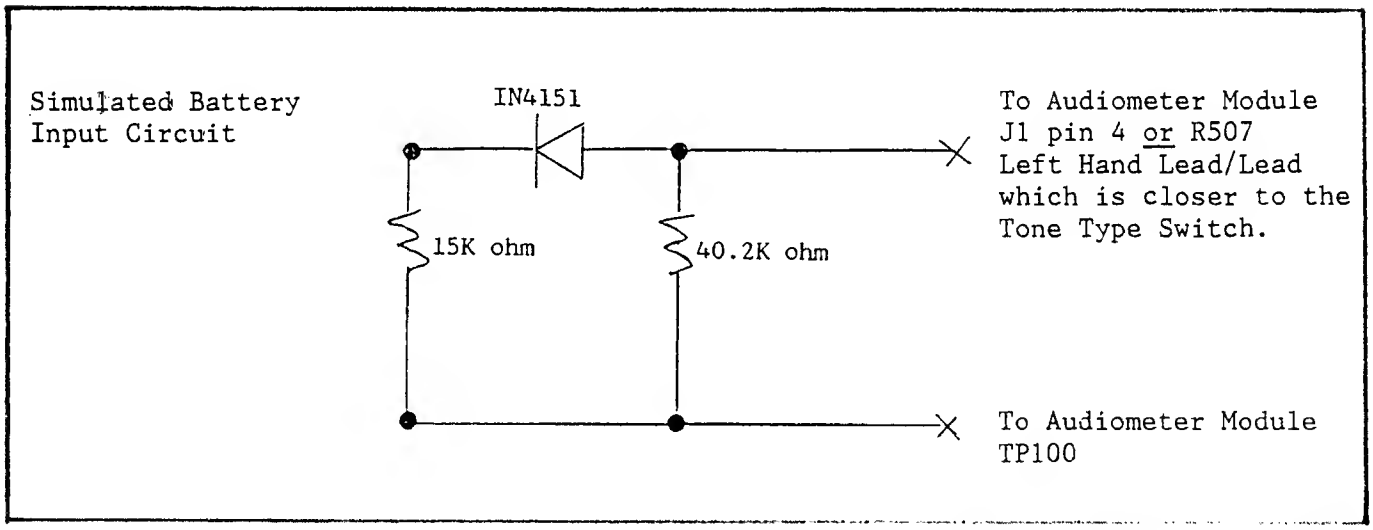

Simulated Battery Input Circuit
IN4151
15K ohm
40.2K ohm
To Audiometer Module J1 pin 4 or R507 Left Hand Lead/Lead which is closer to the Tone Type Switch.
To Audiometer Module TP100

Figure 4-3: BATTERY SIMULATOR

Components Required	GSI Part No.
15 K ohm resistor, 5%, 1/4" W	6099-3155
40.2 K ohm resistor, 1%, 1/4" W	6350-2402
IN4151 Diode	6082-1001

EQUIPMENT REQUIRED

Variable DC power supply, operating range of +6.5 Vdc to +7.5 Vdc minimum DVM.

1. Adjust DC power supply to 7.5 Vdc then connect the negative terminal to TP100 and the positive terminal to TP101.

2. Connect DVM to Audiometer Module TP1000 (LOW) and TP102 (HIGH).

3. Connect simulated battery input circuit to Audiometer Module as indicated in Figure 4-3.

4. Power up the GSI 17.

5. Enter Diagnostic Mode (D3).

   a) Place Dip Switch S2 positions 1, 3, 4 to the ON position.

   b) Place the Cal/Norm Switch to the Cal position.

6. The GSI 17 display will momentarily display D3, then will update to a converted A/D value. Adjust the DC power supply voltage to obtain 7.30 Vdc (±50 mV) on the DVM. Store the new A/D value in memory by pressing the +10 dB Range Extender Button. The display will momentarily display L1 indicating proper storage of data into memory. (It is important that the +10 dB button is pressed only once. If L2 is displayed, exit Cal Mode, return to Step 5 and repeat procedure.)

7. Adjust the DC power supply voltage to 7.0 Vdc (±50 mV). Store this A/D value into memory by pressing the +10 dB Range Extender Button. The display will momentarily display L2 indicating proper storage of data into memory.

8. Adjust DC power supply to 7.5 Vdc. Place all Dip Switch S2 positions to OFF, and place Cal/Norm Switch S6 to the Normal Mode position.

9. Slowly decrease the DC power supply voltage until the LOW BAT indicator is displayed. This should occur between 7.25 and 7.35 Vdc. Continue decreasing the input voltage. The display should blank at 6.95 to 7.05 Vdc. NOTE: To clear the **LOW BAT** indication the unit must be returned to full power and the power switch toggled.

After completing calibration and verification checks remove the power supply and simulated battery input circuit and proceed with calibration of transducers.

4.9.5 ATTENUATOR MAXIMUM OUTPUT LEVEL CALIBRATION (D4)

NOTE: If Default Data is loaded, this procedure must be performed before calibration of earphones.

TEST DESCRIPTION

If the Microprocessor of the GSI 17 has been replaced or a major calibration data loss has occurred the Attenuator Maximum output level must be calibrated. When performing this calibration, the operator will measure the output level on the connector (important-unloaded) of the currently selected transducer and adjust the attenuator position until correct output voltage is measured. The calibration data is then stored and the process is repeated for all remaining stimuli. The stimuli may be calibrated in any order, but all must be calibrated. Originally all output levels were adjusted to 2.5 vrms ±.15 vrms for each frequency. The newer GSI 17's have specific maximum output levels for calibration. Serial numbers and output levels are outlined below.

NOTE : When performing this procedure, output must be unloaded (no phone plugged in).

SERIAL NUMBERS LESS THAN 1230 (EXCLUDING 1068, 1175r AND 1212)

All frequencies 2.5 vrms (±.15 vrms)

SERIAL NUMBERS GREATER THAN 1230 (INCLUDING 1230, 1068, 1175, AND 1212)

Frequency (Hz)	Voltage (rms) (±.5 dB)
125	2.30
250	2.30
500	2.15
750	1.90
1K	2.50
2 K	2.50
3 K	2.50
4 K	2.50
6 K	2.50
8 K	2.50

TEST INITIALIZATION

When switched into the attenuator maximum output level calibration the instrument will be initialized as follows:

Tone Type = Current Selection
Frequency = Current Selection
Stimulus Mux = Oscillator Position
Channel = OFF
Attenuator Position = 255
+10 dB Pad = Out
Transducer Routing = Current Selection
HL Display = Displays "D4" for 2 seconds and then "255"
Response LED = OFF
Stimulus On LED = OFF
Low Battery Segment = Current State
"+" Segment = OFF

TONE TYPE SWITCH

This switch selects the tone type. The calibration would normally be performed with Steady selected.

SWITCH ROUTING

This switch selects the transducer.

FREQUENCY SELECTOR

This knob selects the stimulus to be calibrated. Its operation is the same as in the Normal Mode.

PRESENT BAR

The Present Bar controls the presentation of the stimulus. It operates in a push ON/push OFF manner so, if it is operated (pressed and released) when the stimulus is OFF the stimulus will be presented and will remain ON until the Present Bar is operated a second time. The +10 dB pad will not be affected by turning the stimulus ON or OFF.

HL SELECTOR

This knob is used to directly set the attenuator position. The position is adjusted by +0.5 dB (1 step) for each clockwise step of the knob and by -0.5 dB for each counter clockwise step of the knob. The allowable range of the attenuator position will be from 0 to 255. When either of these limits are reached the attenuator position will not change and the HL display will be flashed.

EXTENDED RANGE PUSHBUTTON (+10 dB PAD)

This pushbutton is used to store the calibration data in the EEPROM. After the calibration data is stored the EEPROM checksum will be updated. If the calibration data can not be stored properly after 3 attempts, the word "CAL" will be flashed on the HL and then the previously displayed value restored. If this error occurs the calibration may still be continued for other stimuli.

SWITCH RESPONSE

This switch is not used during the attenuator maximum output level calibration and all operations will be ignored.

HL DISPLAY

This display is used to display the attenuator position in the range of 0 to 255 as selected by the HL selector. It will be displayed in a right justified, integer format on digits 1, 2 and 3.

LED RESPONSE

This LED is used to indicate the correct storage of calibration data in the EEPROM when the Extended Range Pushbutton is operated. This LED is normally OFF and will be turned ON for 2 seconds after the calibration data has been stored and verified. If the data is not stored correctly, the LED will remain OFF and the word "CAL" will be flashed on the HL display and then the previously displayed value will be restored.

STIMULUS ON LED

This LED is used to indicate stimulus presentation. The LED is OFF when the stimulus is not being presented and on when it is being presented.

LOW BATTERY SEGMENT

This LCD segment indicates a low battery voltage condition.

"+" SEGMENT

This LCD segment will be OFF to indicate that the position of the +10 dB pad is out.

SECTION 5

Disassembly

WARNING

Before proceeding with any disassembly, ensure that the power is disconnected from the instrument.

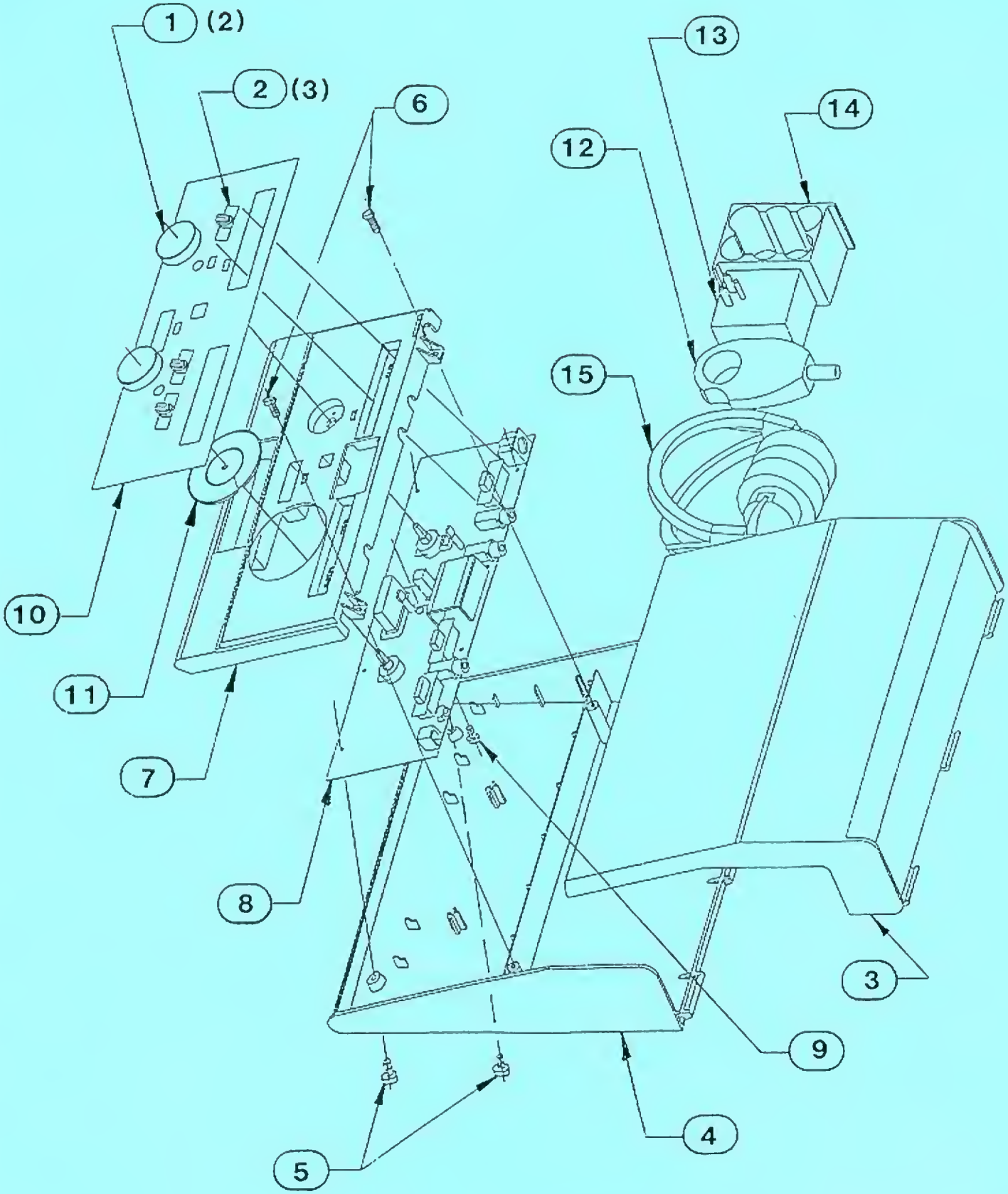


Figure 5-1: DISASSEMBLY

CAUTION: STATIC SENSITIVE DEVICES -
USE PROPER PRECAUTIONS WHEN HANDLING AND SERVICING.

5.1 DISASSEMBLY INSTRUCTIONS

a. Disconnect GSI 17 from power. (Battery Pack and/or Power Module).

b. Disconnect and set aside all accessories.

c. Remove 2 round control knobs, Item 1.

d. Remove 3 slide switch caps, Item 2.

e. Close top cover, Item 3.

f. Turn instrument over onto its side.

g. Open top cover.

h. Remove 2 screws, Item 5, from bottom of instrument.

i. Set instrument down.

j. Remove 2 screws, Item 6, at back of front panel.

k. Lift front panel and printed circuit board, Items 7 and 8, away from bottom case, Item 4.

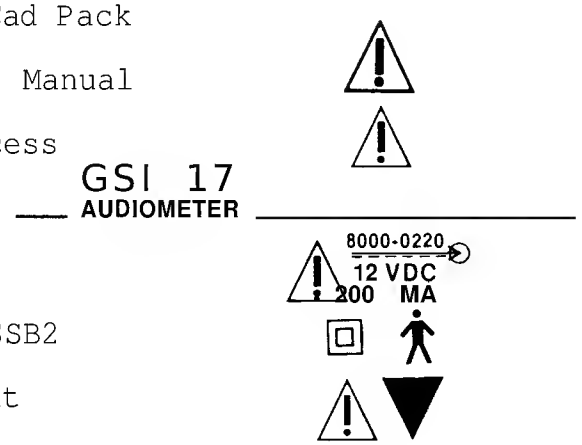
1. Remove screw, Item 9, in back of printed circuit board.

5.2 PARTS NUMBERS

ITEM NUMBER	DESCRIPTION	PART NUMBER
1	HL & Frequency Knobs	1717-7006 & (5220-0101)
2	Slide Switch Caps (Power, L/R, Tone Type)	1717-7007
3	Top Cover (blank/no labels)	1717-7002
4	Bottom Case (blank/no labels)	1717-7001
5	#6 Screws	7044-0037
6	#6 Screws	7044-0037
7	Front Panel (blank/no labels)	1717-7000
8	Printed Circuit Board	1717-4700
9	#6 Screws	7044-0037
10	Front Panel Label	1717-0401
11	Frequency Dial	1717-7003 & (1717-0402)
12	Handswitch	7874-0156
13	Power Module	(see Power Module Sec.)
14	Back Pack	(see Battery Opt. Sec.)
15	Headset Assembly, TDH-39P, 50 ohms	8000-0175

5.3 ACCESSORIES & REPLACEMENT PARTS

Earphone, TDH-39P, 50 ohms	8000-0046 (1 **ea)**
Earphone Cushion, Type MX-41/AR	8000-0143 (1 **ea)**
Headband	8000-0142
Phone Cord Assembly (L and R)	4204-0147
Headphone Audiocups	8000-0155
Patch Cord, 2 Cond.	4204-0505
Audiogram Form, 1 pad of 50	1717-9600
Instruction Manual	1717-0100
Service Manual	1717-0110
Replacement NiCad Pack	8410-0060
Label, Consult. Manual	1717-0425
Label, H.L. Recess	1717-0426
Label, Cover	1717-0410
Label, Power	1717-0415
Label, 601-CLASSB2	1717-0420
Label Adjustment	1717-0430



SECTION 6

Troubleshooting

6.1 TROUBLESHOOTING USING THE HARDWARE DIAGNOSTIC MODE (D0)

This mode is very useful for troubleshooting purposes because it allows control of all blocks of circuitry independent of calibration data.

Diagnostic Mode D0 is selected by placing Dip Switch #1 to the "ON" position, Dip Switches 2, 3 and 4 to the "OFF" position, and then selecting Cal Mode via the Cal Normal Mode Switch. When the Cal/Norm switch is placed in the cal position the display will momentarily display D0, then the display will update to the current DAC value. The default value for DAC is 255 and its overall range is from 0 to 255.

The DAC value is changed by rotating the HL knob clockwise or counterclockwise. This value corresponds to a particular output level used to drive the Voltage Control Attenuator (VCA).

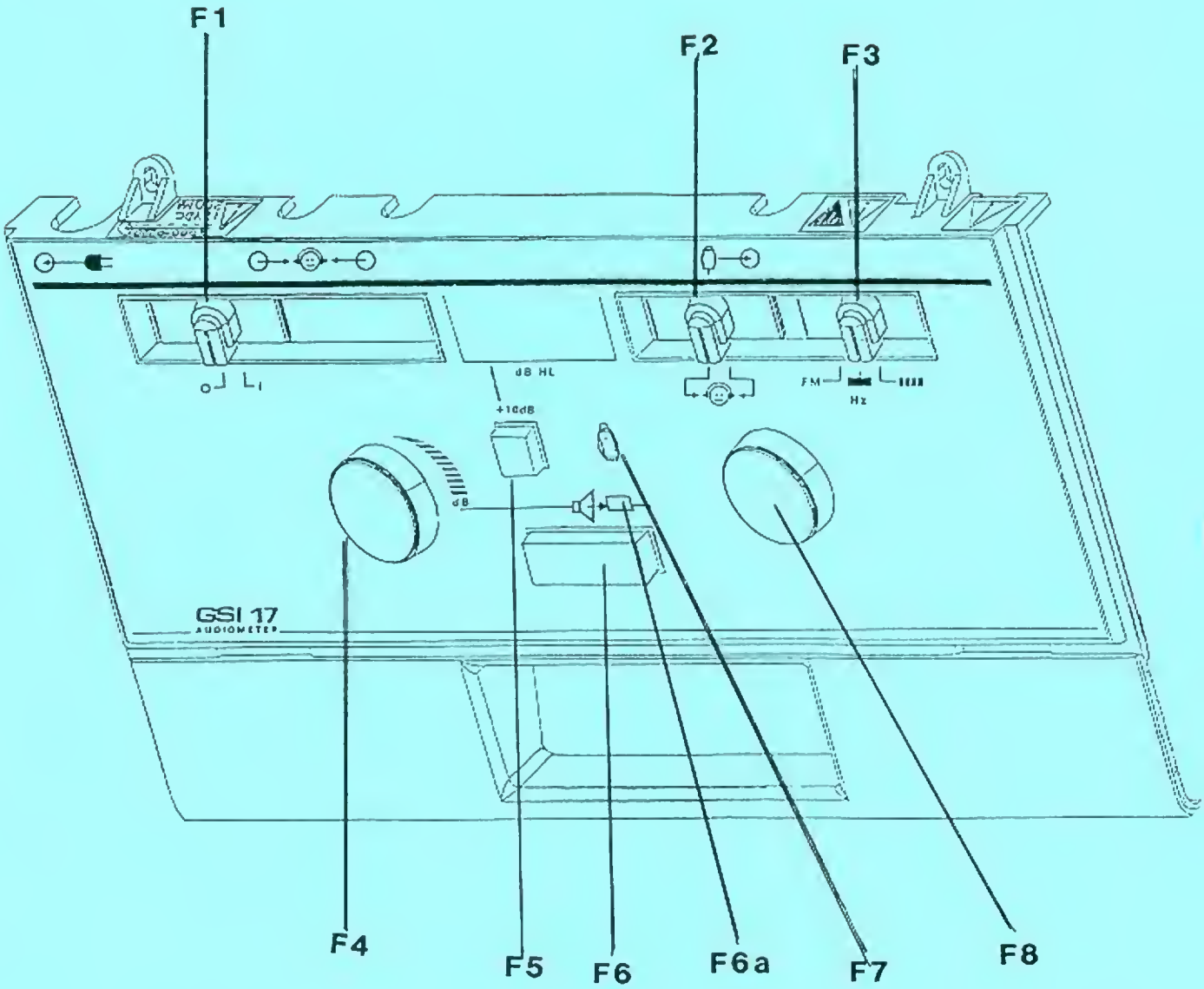


Figure 6-1: DIAGNOSTIC MODE CONTROLS AND FUNCTIONS

DIAGNOSTIC MODE FUNCTION CONTROLS

Function controls for the Diagnostic Mode DO are as follows:

F1- Power Switch	Same as Normal Operating Mode - active at all times.
F2 - L/R Routing Switch	This 3 position switch is active at all times in the Diagnostic Mode. Left Position - Output is not routed to either amplifier. Both amplifiers are disabled. Right Position - Output is routed to the left amplifier. Center Position - Output is routed to the right amplifier.
F3 - Tone Type Switch	Same as Normal Operating Mode - active at all times.
F4 - HL Knob	The HL knob is used to control the DAC level while the display indicates the current DAC level. The DAC level range of 0 to 255 along with the +10 dB range extender allows the operator to check the full range of the attenuator. All voltages in the troubleshooting section will be referenced to a specific DAC level.
F5 - +10 dB Range Extender	Active at all times this Push ON/Push OFF selection allows the operator to change the state of the 10 dB range extender. (+) indicator of LCD indicates the Range Extender is active.
F6 - Present Bar	Active at all times this Push ON/Push OFF selection allows the operator to turn the channel OFF and ON. The channel OFF/ON is accomplished using the attenuator. It is important to note that the latch is updated continuously when the Present Bar is ON otherwise the latch is updated only when the tone is presented.
F6A - Stimulus on LED	Same as Normal Operating Mode - indicates ON or OFF state of the Present Bar.
F7 - Response Switch LED	In the Diagnostic Mode the handswitch is used to ENABLE/DISABLE the Tone Oscillator. This is beneficial when measuring signal to noise. The LED indicates the status of the Tone Oscillator.
F8 - Frequency Selector	Active at all times - same as Normal Mode.

NOTE: Refer to Calibration Mode for more in-depth description of control functions (Cal/Norm Switch, Dip Switches, etc).

6.2 OUTPUT RELATED TROUBLESHOOTING SYMPTOMS

Symptom	Possible Solution(s)
Output failures	Earphone Cord, Earphone, Patch Cord/Jack Panel - If applicable, Amplifier, Output Routing, Amp Enable/Disable, L/R Switch, Amp Latch/Control Circuit.

GENERAL APPROACH TO FAULT ISOLATION

If the loss of output is isolated to only one of the earphones then try exchanging the earphone assemblies. Plug the left earphone into the right earphone jack and the right earphone into the left earphone jack. If the problem shifts to the opposite earphone, then the problem is internal to the Audiometer. If the problem remains with the original earphone, then the earphone assembly is at fault. If the earphone assembly is found to be defective, first check the set screws and assure that they are tightened securely. If the screws are loose a problem similar to this would result. If the screws are secure try exchanging the left and right earphone cords, assure that the earphone serial numbers are legible, if not mark the earphones accordingly. The earphones are calibrated specifically to the left and right amplifiers. If the problem shifts to the opposite earphone then the phone cord is defective. If the problem remains with the original earphone then the earphone is defective.

CIRCUIT ANALYSIS FAULT ISOLATION

Refer to Audiometer Board Schematic #3, Section 8.

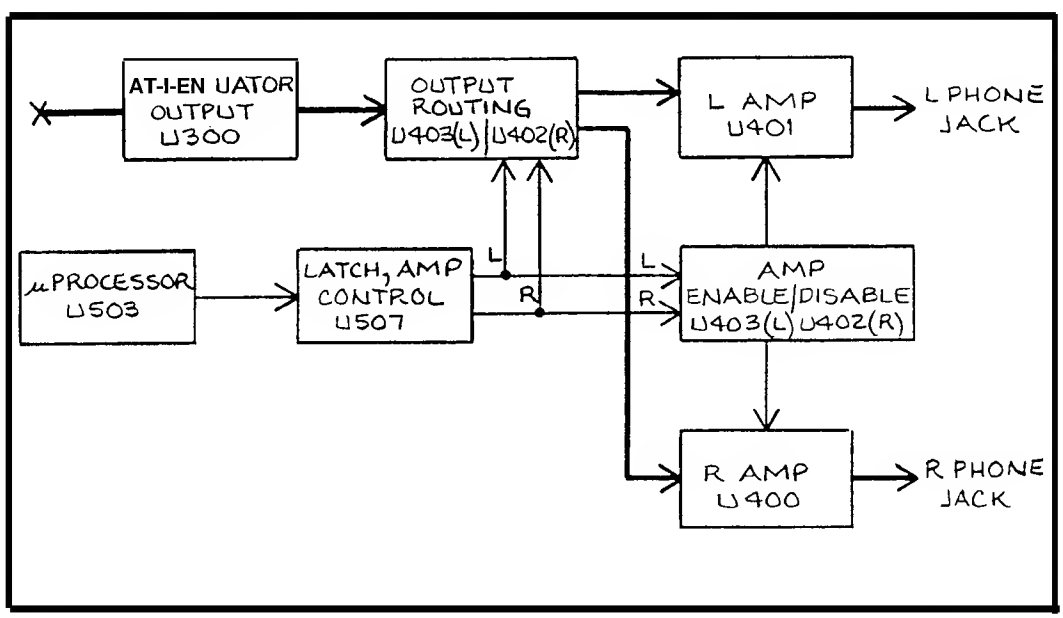


Figure 6-2: BLOCK DIAGRAM OF AMPLIFIER SIGNAL FLOW

6.3 LEFT OR RIGHT AMPLIFIER TROUBLESHOOTING SYMPTOMS

(Refer to Figure 6-2: BLOCK DIAGRAM OF AMPLIFIER SIGNAL FLOW)

ALL VOLTAGES MEASURED WITH THE CHANNELLONQR R SELECTED ACCORDINGLY, 1 kHz FREQUENCY, OUTPUT LOADED.

Check for signal presence/absences at the amplifier output pin
U400 pin 5 - Right
U401 pin 5 - Left

This should be an undistorted sinew ave of approximately 80 m vRM S. Removing the earphone (load) should cause the output level to increase significantly.

If the signal is present here, but not at the earphone it is possible that the phone jack is at fault or an artwork etch connection is missing. Perform point-to-point connection checks as necessary. If the signal is not present here, check the amplifier input pin
U400 pin 3 - Right
U401 pin 3 - Left

This input level should be an undistorted sinew ave of approximately 80 m vRM S. If the input signal is present here but not present at the amplifier output pin then the amplifier may be defective. First check the amplifier enable line
U400 pin 1 - Right
U401 pin 1 - Left
for a logic 0 (-5 Vdc). A logic 1 (+5 Vdc) disables the amplifier for muting or to conserve power. If a logic 0 is present then verify that the +5 Vdc and -5 Vdc power supplies are present. If amplifier enable line and power supplies check out okay, the amplifier is most likely defective.

If a logic 0 (-5 Vdc) is not present at the amplifier enable line then check
U507 pin 16 - Right
U507 pin 19 - Left
for a logic 1 (+5 Vdc). If a logic 1 is present then U402 Right or U403 Left could be defective. Check the power supply lines accordingly.

NOTE: The U507 latch output may be loaded by a defective U402 or U403. Remove U402 or U403 respectfully, then recheck the control lines U507 pins 16 and 19. If these voltages are now correct then U402 or U403 is defective. This type of error occurs quite frequently with CMOS.

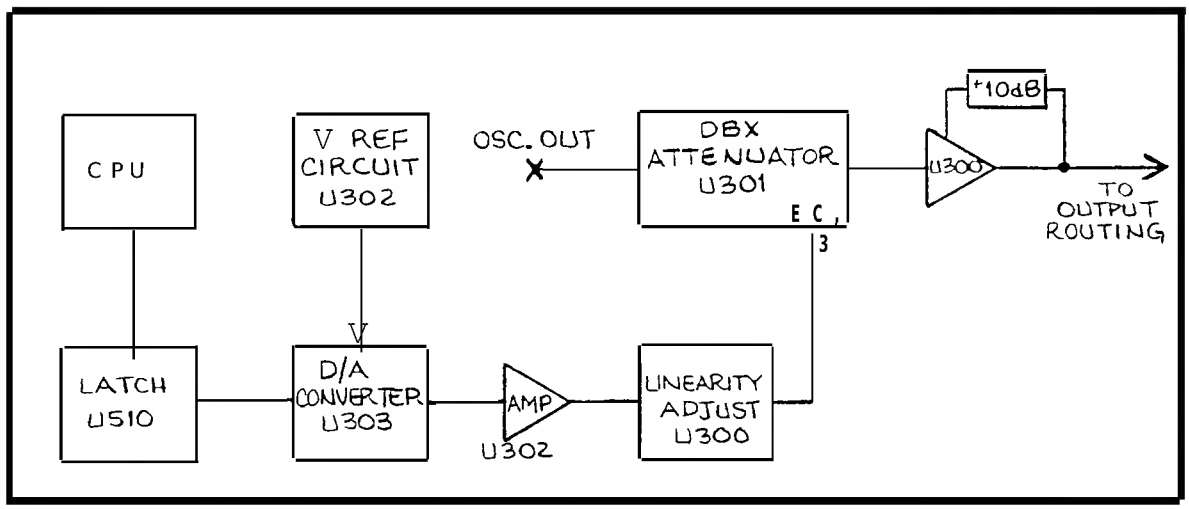


Figure 6-3: BLOCK DIAGRAM OF ATTENUATOR SIGNAL FLOW

6.4 ATTENUATOR TROUBLESHOOTING HINTS

(Refer to Figure 6-3: BLOCK DIAGRAM OF ATTENUATOR SIGNAL FLOW)

Non linearity, no output, large shifts in output level.

The VCA (U301) output is controlled by a dc voltage produced by the D/A converter (U303) The input to the D/A converter is controlled by the processor via the latch (U501). If the output from the attenuator circuit is not present at the output routing circuit check the following.

NOTE: Calibration data is used to update the latch circuit. Assure that the calibration data is appropriate or select Diagnostic Mode DO.

In Diagnostic Mode DO the display will indicate a DAC value of 255 all bits at the latch output should equal +5 Vdc and the attenuator should be at max attenuation. Turning the HL knob clockwise should cause the DAC value to decrease and the output level to increase. At a DAC value of 0 the latch outputs should all be low and the output should be at minimum attenuation/maximum gain. (The latch is updated continuously when the Tone Bar is ON, otherwise the latch is updated only when the tone is presented).

Use the following table to check various circuit voltages for proper level.

Table 6-1: ATTENUATOR CIRCUIT TEST CHECK

NOTE: Voltage measurements with DAC value of 0, 1 kHz Frequency and Tone Steady.

Measurement Location		Expected Voltage	
Junction R314 & R316 (R Side) - Osc. out		.2 VRMS	
U303 Pin 15 - DAC Voltage Reference		3.35 Vdc	
		Tone OFF	ON
U303 Pins 4 thru 11		+5 Vdc	0 Vdc
U302 Pin 7		-3.4 Vdc	0 Vdc
U300 Pin 7		+ .5 Vdc	-.15 Vdc
U300 Pin 1		0 VRMS	1.2 VRMS
Junction R313 & R311 (R Side)		-3.4 Vdc	0 Vdc
10 dB Range Extender Check			
		Pad OUT	Pad In
U300 Pin 1	DAC = 0	1.2 VRMS	* 3.5 VRMS
	DAC = 10	.7 VRMS	2.1 VRMS

* Sine Wave should have "clipping" evident on negative and positive slopes. Increasing DAC value to 5, 6, or 7 should decrease output level and eliminate clipping.

6.5 OSCILLATOR TROUBLESHOOTING HINTS

As a rule the only test equipment carried by service representatives is a Digital Volt Meter (DVM). The oscillator circuitry is generally difficult, if not impossible to troubleshoot in the field using a DVM. Various power supply pins may be checked at specific IC's on the oscillator circuit and output pins may be checked for "relative" output level. In this instance relative refers to an estimated voltage output dependent on the frequency selected and the speed at which the DVM's circuitry measures its input signal. Generally when measuring a 0 Vdc to **5** Vdc square wave with a **50/50** duty cycle the dc voltage should measure **2.5** Vdc. A measurement of **>4** Vdc or<1 Vdc would indicate steady state output. Likewise an ac RMS measurement of **2.5** VRS would be normal and an ac reading of 0 V would indicate steady state. This type of information allows us to check for the presence or absence of signal flow. Using this information can sometimes point to open connections, defective amplifiers and switches, or other hardware failures.

The most effective way to troubleshoot the oscillator is with an oscilloscope. The ocsilloscope enables visualization of the sinewave or square wave. Distortion or frequency errors become obvious and signal level may be observed at the same time.

The oscillator circuit is located on the Analog Board Schematic #1. The oscillator output is routed to the attenuator circuitry via the Filter Multiplexer (U 200). The Filter Multiplexer routes the appropriate signal to the input of the attenuator circuit. This signal is either the oscillator output Band Pass filtered (BP), Low Pass filtered (LP), or a test signal input. The antialliasing filters round the edges of the square wave clock input prior to filtering.

If the oscillator circuit is non-functional verify that the square wave clock signal is present at U511 **-** pin 10. This is a **O-5** Vdc **(2.5** VRMS) square **wave** which should be the same frequency as indicated on the front panel. The output of the antialliasing filter U203 pin **-** 7 should be a square wave with rounded edges and its voltage swing should be approximately -3.5 V to +3.5 Vdc (2.5 VRMS). The output of the Switched Capacitor filter should be a clean undistorted sinewave with a voltage swing of -5 Vdc to +5 Vdc (2.5 VRMS).

6.6 TROUBLESHOOTING THE PROCESSOR (U503)

There are some processor related problems that can be repaired in the field. The processor on the audiometer board is a multi-combination device. It has its own internal EEPROM, D/A converter, RAM, watch dog circuitry, Priority Interrupt function, and a free running timer. Processor errors are generally associated as lock-ups. Lock-ups occur for various reasons. A shorted or loaded address or data line will stop the processors execution process, the result is a 'lock-up'. When this occurs the processor will generally continue to strobe the address and

data lines. In this instance probe these lines with an oscilloscope and look for any address or data lines that are in-active (no data or periodic state transition). If an in-active line is found the processor may be at fault but the problem is most likely a bad port or latch somewhere on the bus. This type of hardware failure generally requires replacement of the Audiometer Board, as this is probably the most cost effective way to resolve this type of problem.

A lock-up may also occur as the result of a defective EPROM (U505). This EPROM contains all the instructions for the processor to execute. If there are no instructions the processor may pause or get "LOST". This type of failure very seldom occurs as these EPROMS are very stable devices.

When a new processor is installed into the audiometer board it may lock-up. There are internal system configuration registers that must be loaded by shorting JP1 pins 1 and 2 (Mode B pin 2 of the processor to ground) prior to power-up. After power-up wait for a period of (2 or 3 seconds) then power the unit down and remove the jumper. The operator/technician should then load default data and perform self calibration (refer to Section 4, Calibration). It is important to note that this problem could also occur if a data error was present in the EEPROM portion of the processor.

6.7 POWER SUPPLY RELATED PROBLEMS

The GSI 17 is powered by battery or by the Power Module (Battery Eliminator/AC Adapter). When a power supply is suspected to be defective, first check the power source. Have the batteries been replaced? Were the batteries new? Dated? Is the power eliminator functioning properly? Is there 13 V present at the connector which attaches to the GSI 17? When these questions have been answered then proceed with troubleshooting on the Audiometer Board. Check for the presence of 7 Vdc to 13 Vdc at the positive terminal of C101 (use TP100 for ground reference). Check the positive terminal of C100 for +5 Vdc. Check the negative terminal of C103 for -5 Vdc.

NOTE: If any power supply voltage is incorrect the problem may be the result of a short or load somewhere on the line.

It is best to try lifting the regulator output pin and measure the lifted pin prior to replacing the device. If the regulator output is correct with the pin lifted, check the power supply capacitors for low impedance or a shorted device.

If the operating life of the batteries appears diminished,the low battery indicator may be improperly calibrated or the GSI 17 is drawing excessive current. Refer to Section 4, Calibration, for the battery calibration procedure.

The current draw of the GSI 17 can be checked by connecting an ammeter in place of the power switch. The current draw in the active mode should be less than 75 ma. In the sleep mode the current draw should be reduced to approximately 16 ma.

6.8 TROUBLESHOOTING THE DISPLAY

Refer to the Calibration Mode, Section 4, for method of entry into the Display Diagnostic Mode (D2).

The LCD Display is relatively easy to troubleshoot. The driver for the Display (U501) sources each segment with a square wave of approximately 36 Hz (28 ms) with a 50/50 duty cycle. All segments of the LCD have a common connection via BP1 and BP2. This Back Plane (BP) is driven continuously with a 36 Hz square the same frequency that the segments are driven at. For the segments to be illuminated (black) they must be driven with a square wave which is 180^{o} out of phase relative to the Back Plane square wave. Any segments which are not going to be illuminated are driven with a square wave that is 0^{o} or in phase with the Back Plane. When the two signals present at the LCD segment are in phase there is no potential across the segment and the segment is OFF. When the two signals are out of phase there is 5 V potential present a all times and the segment is ON. Generally, if a segment is missing an AC meter can be used to check for proper phase relative to the Back Plane. An AC measurement of 5 V would indicate the signals are out of phase and that the segments should be illuminated. An ac measurement of 0 V would indicate that the signals are in phase. An ac measurement relative to ground should indicate 2.5 VRMS. This would indicate the presence of a square wave. A dc measurement of 0 Vdc or 5 Vdc would indicate steady state or a possible open connection. With this information it should be relatively easy to establish if the driver or LCD segment is at fault.

6.9 SWITCH RELATED FAILURES

Refer to the Calibration Mode, Section 4, for method of entry into Pushbutton Diagnostic Mode (D1). The Pushbutton Diagnostic test can be used in troubleshooting all the front panel switches and dip switches independent of their Normal Mode functions. It should be relatively easy to isolate switch failures using this mode.

6.10 ERROR MESSAGES

The GSI 17 will display a Diagnostic Error Message should a condition exist which may cause incorrect or unreliable operation of the instrument. If an error is detected normal operation of the instrument will be aborted and the instrument will stop operating. The condition of the error will be indicated to the operator by displaying an abort code on digit 1, 2, and 3 of the HL Display. The error message will be displayed in the format of "Exx" where xx is a 2 digit abort number to identify the type of abort.

When a system error occurs which causes the instrument to halt operation, the following will occur:

1. If the channel is "ON" it will be turned OFF.
2. All transducers will be disconnected from the channel.
3. The Watch Dog (COP) timer and clock monitor will be disabled.
4. The HL dispiay will display the error code.
5. The CPU will be put into a state which will halt its operation and not allow it to resume unless the power is cycled.

The system error conditions to be tested for and their codes are as follows:

Error Code	Probable Cause and Solution
E01	EPROM FAILURE - Indicates the EPROM checksum was in error at power up. If not recoverable replace U505 then U503 If the problem is not resolved by replacing U505 or U503 then check for Buss loading, open traces, or shorted traces between U505 and U503.
E02	RAM FAILURE - If not recoverable replace U503.
E03	WATCH DOG TIMER ERROR - If not recoverable replace U503
E04	CPU CLOCK FAILURE - If not recoverable replace U503.
E05	UNDEFINED INTERRUPT ERROR - If not recoverable replace U503 then U505.
E06	OPCODE TRAP ERROR - If not recoverable replace U503 then U505.

Error Code	Probable Cause and Solution
E07	INVALID TONE SWITCH SETTING - If not recoverable replace S5 then U503.
E08	INVALID FREQUENCY SWITCH SETTING - If not recoverable replace RE2 then U503.
E09	INVALID ROUTING SWITCH SETTING - If not recoverable replace S4 then U503.
E10	UNDEFINED KEY CODE ERROR - This error may occur with the failure of any front panel control. If not recoverable replace U503 then U505.
E11	CONFIGURATION REGISTER ERROR - The processors internal registers are not properly configured. With the power switch OFF install a temporary jumper wire (short) across JP1 pins 1 and 2. Then place the power switch in the ON position and wait for approximately 10 seconds. The processor's registers should now be properly configured. Return the power switch to the OFF position and remove the jumper wire. If the problem still exists replace the processor U503 and repeat the above procedure.
E12	LOW VOLTAGE ERROR - Battery Low/Shut Down adjustment is not set to within the acceptable range. If not recoverable perform Battery Low/Shut Down Calibration (Calibration Section 4.9.4). If the problem still exists replace U503 and repeat procedure.
E20	CALIBRATION DATA READ ERROR - If not recoverable replace U503. NOTE: Re-cal may clear.
E21	HL LIMIT EXCEEDED - If not recoverable replace U503. NOTE: Re-cal may clear.
E22	INVALID EXTENDED RANGE SELECTION - If not recoverable the problem may be related to U509, U506, U508 or U503.
E23	CALIBRATION DATA WRITE ERROR - Should occur only in the Calibration Mode. If failure is not recoverable replace U503.
E24	INVALID PRESENT BAR DUE TO CALIBRATION ERROR - Should occur only in the Calibration Mode. If not recoverable replace U503.
E25	ERROR PERTAINS TO FACTORY CALIBRATION PORT - If not recoverable replace U503.

Error Code	Probable Cause and Solution
E26	EEPROM CHECKSUM ERROR - Data in the Mirror Memory is in error. If not recoverable perform calibration. If the problem is not resolved by calibration replace U503.
E27	EPROM TO EEPROM DATA LOAD ERROR - If not recoverable replace U503 then U505.
E28 & E29	CALIBRATION TYPE READ ERROR - Should occur only upon entry to Calibration Mode. If not recoverable the problem may be related to S2, S6, U509, U508, U506, or U503.
E31	BATTERY SHUT DOWN LEVEL READ ERROR - If not recoverable perform Battery Low/Shut Down Calibration (Calibration Section 4.9.4). If the problem persists replace U503.
E32	BATTERY WARNING LEVEL READ ERROR - If not recoverable perform Battery Low/Shut Down Calibration (Calibration Section 4.9.4). If problem persists replace U503.
E33	STACK OVERFLOW ERROR - Should always be recoverable. If the error persists replace U503 or U505.
E34	BAD POINTER TO EEPROM ROUTINES - If not recoverable replace U505 then U503.
E35	INVALID KEY CODE ERROR - If not recoverable replace U505 then U503.
E36	INVALID KEY SOURCE ERROR - If not recoverable replace U505 then U503.
E37	INVALID QUEUE POINTER ERROR - If not recoverable replace U505 then U503.
E38	BATTERY VALUE OUT OF RANGE - If not recoverable perform Battery Low/Shut Down Calibration (Calibration Section 4.9.4). If problem persists replace U503.
E39	ERROR PERTAINS TO FACTORY CALIBRATION PORT - If not recoverable replace

SECTION 7

Block Diagram

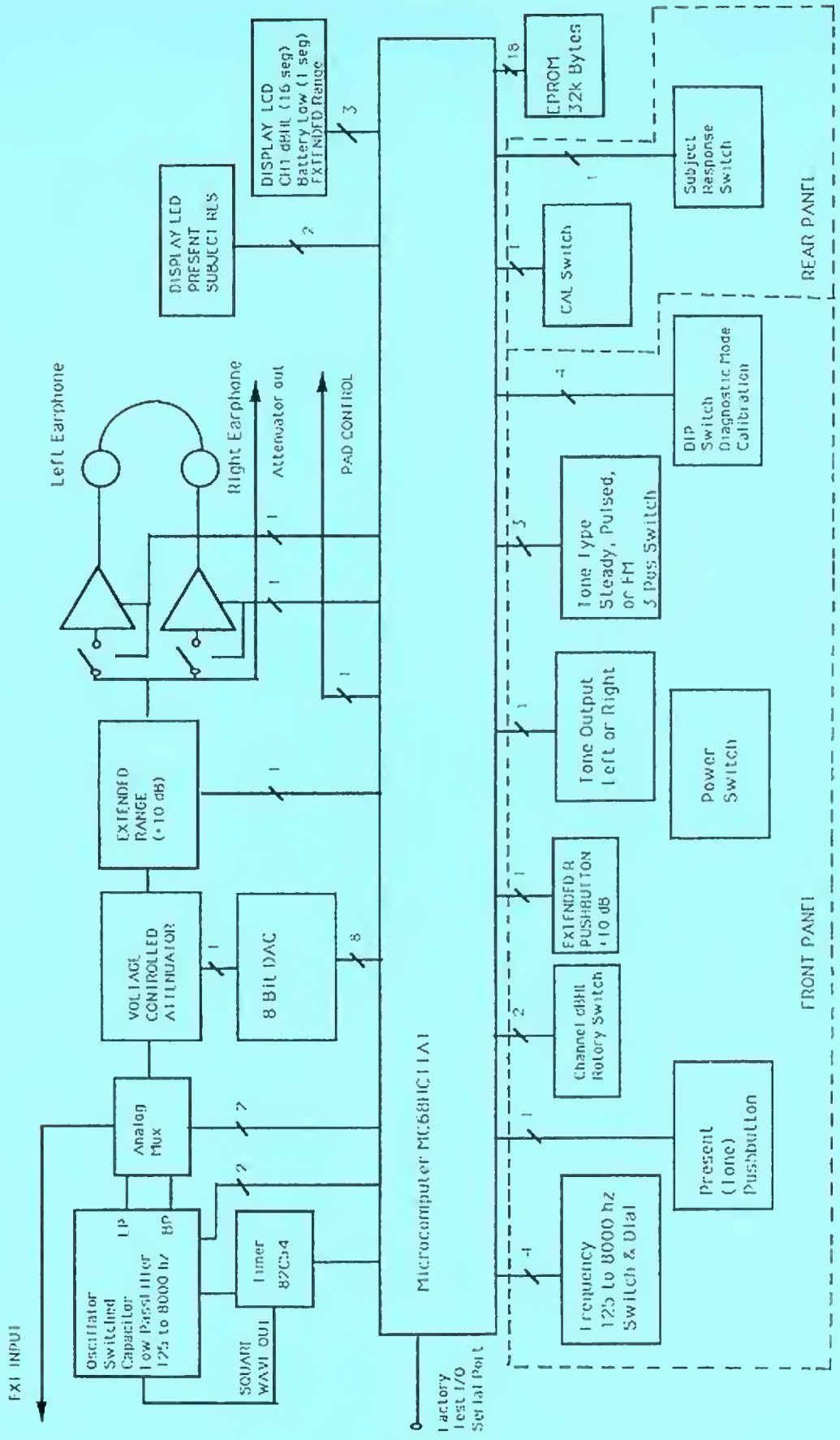


Figure 7-1: BLOCK DIAGRAM

7.1 ANALOG CIRCUIT

A square wave at the desired frequency is generated by a timer internal to the microprocessor. This square wave is applied to the input of switched capacitor filters for smoothing into a sine wave. The filter section is programmed as Low Pass for all frequencies except 8 KHz where it is configured for Band Pass. Since there are two filter output configurations, a multiplexer (switch) is used to route the sine wave to the attenuator block.

The attenuator is a voltage controlled amplifier set to .5 dB resolution by an 8 bit Digital to Analog Converter (DAC). The DAC, which is processor driven, controls the attenuator in the Normal Mode at a resolution of 5.0 dB. The .5 dB resolution is used only for calibration purposes in the Calibration Mode. The total dynamic range of the attenuator is 112 dB. This range is required to provide the Normal Mode HL range as well as the overhead dB range required for calibration per frequency.

Following the attenuator is a =10 dB range extension block. Range extension is accomplished by increasing the gain of the OP-Amp, which is sourced by the attenuator, by 10 dB.

The range extender circuit applies the pure tone sine wave to the input of the output routing switches. The switches apply the signal to either the left or right power amplifier, however, it is never applied to both simultaneously. The left and right power amplifiers, in turn, drive the left and right earphones.

7.2 DIGITAL CIRCUIT

The heart of the digital circuitry is a MC 68HC11A1 microcomputer. This CPU was chosen for its flexibility and low power consumption. Functions available from the device are (5) 8 bit programmable I/O ports, an 8 bit analog to digital converter (A/D), 8 K Bytes of ROM, 256 Bytes of RAM, 512 Bytes of EEPROM, Counter/Timer, and Serial Port Interface. As a result, there are very few external support devices required. If there is an external EPROM (32 K Bytes), a programmable timer, and miscellaneous decodes, line multiplex, etc.

The CPU executes the commands stored in ROM and EPROM. These instructions are the result of a front panel command in conjunction with look-up tables, and such, for applying the pertinent calibration data for the selected parameters. Such parameters could be: HL calibration for a specific frequency, clock frequencies for the switched capacitor filters, display instructions, or as simple as an ON/OFF command to a CMOS switch.

In summary, the digital circuitry in the GSI 17 controls the analog and display circuitry in such a manner that the front panel selections are processed and acted upon accordingly.

SECTION 8

Audiometer Module (1717-4700)

8.1 GENERAL NOTES

a. The Audiometer Board is a self-contained audiometric module. If the board is changed, the headphones must be calibrated to the board.

b. If during the calibration process, default data is loaded then diagnostic mode D5 procedure must be performed (see Section 4, Calibration of this manual).

c. If the micro controller or audiometer board is changed then default data, and Diagnostic Mode D5 procedure must be performed.

8.2 MICROCOMPUTER (U503)

The MC68HC11A1 is an 8 bit MCU with sophisticated on-chip peripheral capabilities. In the GSI 17's application it operates at a nominal 1 MHz bus speed. The HCMOS technology used combines smaller size and higher speeds with the low.power and high noise immunity of CMOS. On-chip memory includes 512 bytes of electrically erasable programmable ROM (EEPROM) and 256 bytes of random-access memory (RAM). The on-chip peripheral functions include:

- Eight channel analog to digital (A/D) converter with eight bit resolution of which two channels (PE6 and PE7) are used to monitor battery functions.

- Free-running timer system that has three input capture lines. Two lines (PA0 and PA1) are used to decode HL direction and amount of change on an edge triggered basis. The third input capture line (PA2) is used to detect left vs. right output selection.

- A real time interrupt function (XIRQ) which is used by the Present Bar for immediate processing of a "Present" command.

- Self-monitoring circuitry is included on-chip to protect against system errors. This "computer operating properly" (COP) watch dog system protects against software failures.

The internal 512 byte EEPROM contains data for the A/D converter relative to the "LO BAT" (Low Battery) threshold and "DEAD BAT" or battery level below usable level threshold. Also stored in the EEPROM are all calibration HL, SPL and attenuator data. This data is stored with a triple redundancy technique. In this method each calibration point per frequency is stored 3 times,

once in each of 3 different blocks within the EEPROM. When a calibration point is requested, the appropriate location in each of the three blocks is read and decoded. For the data to be valid the value from 2 of the 3 blocks must match. If a calibration error is detected, the frequency and transducer which would use the data will not be available for testing by virtue of the channel being forced off. The instrument will continue to function for all combinations of frequencies and transducers which have valid calibration data. This memory retains its data even when power is not applied to the device.

The internal 256 bytes of RAM is used in a "scratch-pad" capacity. It's used as a temporary storage medium for such functions as adding HL dial to transducer RTL for a given output setting. This memory can only retain data when it has power applied to it.

8.3 EPROM U505)

The **32** K byte by **8** bit EPROM contains the operating instructions for the GSI **17.** The microcomputer fetches data from the EPROM and executes the instructions accordingly. The instructions for the Normal calibration and diagnostic modes are contained in this memory. EPROM is non-volatile memory, meaning that data storage is not lost when power is removed from the device.

8.4 TIMER (U511)

There is a programmable timer chip which is used for 3 different functions via 3 programmable outputs. One output is the square wave (SQWIN) which ultimately gets filtered into the pure tone used for presentation into the earphones. A second output is the clock (SCFCLK) for setting the switched capacitor filter 3 dB points. These first two outputs (SQWIN, SCFCLK) have variable output frequencies dependent upon the front panel frequency selected. The third output is a set pulse train which sends a negative-going .2 used pulse every **2** msec to the CPU. These pulses are used as an interrupt for the processor so that it can update the COP circuit and perform the polling of the status of the controls not previously mentioned.

8.5 POLLED CONTROLS

The majority of controls are read via a polling technique. That is, the CPU reads the status of each key/control at pre-determined rates of time. The polling in the GSI 17 takes place at a rate of 12 msec. Every 12 msec a control is "looked at" for status, then if that control is determined to be in the same status 12 msec later, it is acted upon. Therefore it can be stated that the following controls are polled and allowed a de-bounce time (settling time) every 12 msec. The keys/controls are as follows:

The HL Knob
The Frequency Dial
The =10 dB Extended Range Key

The Left/Right Control
The FM/Pulsed/Steady Control
The Subject Response Switch
The Calibration/Normal Mode Switch
The Calibration/Diagnostic Mode Dip Switch(s)

8.6 INPUT/OUTPUT (I/O) PORT DESIGNATIONS

Physical Port	Bit	Signal Name	Direction	Description
U503 PORT(A)	0	HL1	IN	HL1 and HL2 form a 2 bit code of the HL selector position.
	1	HL2	IN	
	2	LEFT	IN	LEFT and UNUSED form the 2 bit code of the Routing Switch position.
	3	SPARE	N/A	Not Used
	4	SPARE	N/A	Not Used
	5	+10 dB	OUT	+10 dB (Extended Range) Pad control. 0 = Pad Out 1 = Pad In (Range Extended)
	6	SPARE	OUT	Not Used
	7	UNUSED	IN	See Bit 2 - LEFT
U503 PORT(E)	3	FREQ1	IN	FREQ1-FREQ4 form the 4 bit code of the Frequency Selector position.
	2	FREQ2	IN	
	1	FREQ3	IN	
	0	FREQ4	IN	

HL2	HL1
Position 1 - 1	1
Position 2 - 1	0
Position 3 - 0	0
Position 4 - 0	1

UNUSED	LEFT
Invalid - 0	0
Unused - 0	1
Right - 1	0
Left - 1	1

SELECT FREQ	LSB FREQ4	FREQ3	FREQ2	MSB FREQ1
125 Hz-	1	1	1	1
250 Hz-	1	1	1	0
500 Hz-	1	1	0	0
750 Hz-	1	1	0	1
1 KHz-	1	0	0	1
1.5KHz-	1	0	0	0
2 KHz-	1	0	1	0
3 KHz-	1	0	1	1
4 KHz-	0	0	1	1
6 KHz-	0	0	1	0
8 KHz-	0	0	0	0
Pos.12-	0	0	0	1

Physical Port	Bit	Signal Name	Direction	Description
U503 PORT(E)	4	PULSE	IN	PULSE and FM form the 2 bit code of the Tone Type switch position.
	5	FM	IN	
				FM PULSE Invalid - 0 0 FM - 0 1 Pulsed - 1 0 Steady - 1 1
U503 PORT(D)	6	BAT/LINE	IN	Voltage Source Status 0=lINE Voltage 1=Battery Voltage
	7	BATVOLT	IN	Analog Battery Voltage input to the A/D converter
U503 PORT(D)	0	RXD	IN	SCI Received Data
	1	TXD	OUT	SCI Transmitted Data
	2	MISO	IN	SPI Input - Not Used
	3	MISI	OUT	SPI Data to Display Driver
	4	SCK	OUT	SPI Clock to Display Driver
	5	SLEEP	OUT	Sleep Mode Status O=Awake 1+In Sleep Mode
	6	N/A	N/A	
	7	N/A	N/A	
U509	0	DIAG	IN	Dip Switch #1 - Diag/Cal Mode O=ON =Enter Diag Mode 1=OFF=Enter Cal Mode
	1	SPARE	IN	Dip Switch #2 - Spare
	2	ALTREF	IN	Dip Switch #3 -GSI/User SPL O=ON =User SPL Mode 1=OFF=GSI SPL Mode
	3	DEFAULT	IN	Dip Switch #4 - Default Data O=ON =Load Default Data 1+OFF=Do Not Load Data
	4	RANGEX	IN	Extended Range Switch Status 0=Pressed 1=Relaesed
	5	SUBRES	IN	Subject Response Switch Status 0=Pressed
	6	CAL	IN	Cal/Normal Mode Switch Status O=Calibration Mode 1=Normal Mode

Physical Port	Bit	Signal Name	Direction	Description
	7	PRESENT	IN	Present Bar Status 0=Pressed 1=Released
U507	0	AFILHI	OUT	Oscillator Antialiasing Filter Select AFILHI 50/100 BP/LP 125 Hz - 0 0 0 250 Hz - 0 0 0 500 Hz - 0 0 0 750 Hz - 0 0 0 1 KHz - 1 0 0 1.5KHz - 1 0 0 2 KHz - 1 0 0 3 KHz - 1 0 0 4 KHz - 1 1 0 6 KHz - 1 1 0 8 KHz - 1 1 1
	1	50/100	OUT	Oscillator Clock Scale Select (see AFILHI for States)
	2	BP/LP	OUT	Oscillator Digital Filter Type Select (see AFILHI for States)
	3	EXTIN	OUT	External Input MUX control 0=Select External Input. 1=Select Oscillator
	4	PRESLED	OUT	Channel ON LED Control 0=LED OFF 1=LED ON
	5	SUBLED	OUT	Response LED Control 0=LED OFF 1=LED ON
	6	RON	OUT	Right Channel Routing Control 0=Channel OFF 1=Channel ON
	7	LON	OUT	Left Channel Routing Control 0=Channel OFF 1=Channel ON
U510	0	DACO	OUT	Attenuator DAC Level Control. 0 ->255
	1	DAC1	OUT	
	2	DAC2	OUT	
	3	DAC3	OUT	
	4	DAC4	OUT	
	5	DAC5	OUT	
	6	DAC6	OUT	
	7	DAC7	OUT	

U511 Timer	Signal Name	Direction	Description
TMRO	SQWIN	OUT	8254 Counter 0 Used for the Oscillator SWQIN
TMR1	SCFCLK	OUT	Clock. Frequency = Stimulus Frequency 8254
TMR2	CLKGEN	OUT	Counter 1 Used for the Oscillator Switched Capacitor Filter SCFCLK. (see the following table 8254 Counter 2 Used to Produce the 2 msec Time-base.

SWITCHED CAPACITOR FILTER CONTROLS

Front Panel/ Freq	Filter Cutoff Freq	Switched Capacitor SCFCLK (Clock) Freq	Timer Setting	50/100 State	Antialiasing AAFIL State	BP/ LP
125	150.38	15,038	266.00	0	0	0
250	300.75	30,075	133.00	0	0	0
500	606.06	60,606	66.00	0	0	0
750	909.09	90,909	44.00	0	0	0
1000	1176.47	117,647	34.00	0	1	0
1500	1818.18	181,818	22.00	0	1	0
2000	2500.00	250,000	16.00	0	1	0
3000	3333.33	333,333	12.00	0	1	0
4000	5000.00	250,000	16.00	1	1	0
6000	8000.00	400,000	10.00	1	1	0
8000	8000.00	400,000	10.00	1	1	1

8.7 DISPLAY (LCD)

The LCD is a reflective 3-1/2 digit Liquid Crystal Display. It is the largest indicator on the GSI 17, and it is used for a variety of purposes. Some purposes are: indication of HL and possible error messages in the Normal Mode, along with SPL and A/D numbers in the calibration and Diagnostic Modes. (Refer to each mode's functional description for detail).

An LCD segment is energized only when there is a 5 Volt potential across it. To confirm if a segment is receiving the appropriate drive signal, connect CH1 of an oscilloscope to the backplane signal and CH2 to the segment drive signal. For an "ON" segment the signals should be out of phase, therefore applying 5 Volts across it.

8.8 OUTPUT ROUTING AND POWER AMPLIFIERS

Analog switches U402 and U403 are used to route the attenuated, and possibly range extended, signal to the left and right power amplifiers. The CPU reads the status of the front panel left/right switch and controls the analog switches accordingly.

The use of two power amplifiers (U400, U401) as well as the ability to turn them off (Pin 1) minimized the potential of cross-channel leakage. The amplifiers, which can deliver approximately 1 watt, can be turned off for minimal current draw. This is a very important feature for use under battery power. A series 130 ohm resistor at their output serves as an attenuator for both signal and noise when the 60 ohm phones are connected.

8.9 POWER SUPPLY

The on-board power supplies consist of a +5 Volt regulator, -5 Volt regulator and a voltage converter. The input supply, whether it be from a battery or a battery eliminator, is approximately +7 Vdc. This positive voltage is applied to the U102, +5 Volt regulator. The positive 5 Volts supplies both the analog and digital circuits. The unregulated +7 Volts is also applied to converter U101 where, through its switched capacitor circuitry, is inverted to -7 Volts. The unregulated negative voltage is then applied to the -5 Volt regulator U100. Note that the voltage converter is disabled (shutdown) whenever the sleep mode is entered. This is accomplished via controls switched through U202.

8.10 OSCILLATOR

The oscillator is comprised of the following IC's and their functions:

U203 - level shifter
U202 - antialiasing filter
U201 - programmable switched capacitor filter
U200 - Low Pass/Band Pass selector

U203 takes the 0 to 5 Volt sqaure wave (from U511.10) at the front panel selected frequency and converts it to a +5 V signal. This signal is then applied to the antialiasing filter. An antialiasing filter "rounds" the edges of the sine wave to eliminate high freqeuncy harmonics. The output of this filter is applied to the input of switched capacitor filter U201. The switched capacitor filter is programmed via clock frequencies and the state of the 50/100 line. U201 (from U507 controls can be found at the end of the I/O port designation listing (see U507). The switched capacitor filter is set to a Low Pass configuration for all frequencies except 8 KHz where it is set for Band Pass. This filter reduces harmonics and any other noises resulting in a clean sine wave product.

8.11 ATTENUATOR AND 10 dB RANGE EXTENDER

The attenuator (U301) is a voltage controlled amplifier. Although it does have amplification gain, the majority of its dynamic range is used as an attenuator. The total range of the attenuator is 112 dB which is adjustable using a variable dc voltage applied to Pin 3 (EC) of the device. In the normal operating mode, the attenuator is set to 5 dB resolution. In the calibration mode, however, 0.5 dB resolution is available and made possible by an 8 bit digital-to-analog converter (DAC).

Earphone calibration is accomplished by storing an HL to SPL value per frequency in a look-up table in EEPROM. For example, at 1 KHz and 80 dB HL the CPU will set the attenuator to a position which will establish 87 dB SPL in either earphone. Therefore, it can be stated, that the attenuator for a given frequency is offset from the nominal indicated HL by a decibel value equal to the Reference Threshold Value (RTV) to a resolution of **±0.5** dB.

The amplifier stage (U300) following the attenuator has a switchable feedback resistor. This stage serves as the +10 dB range extender circuit used during normal operation. The gain of the stage is changed by switching Resistor R304 in parallel with R303 or grounding R304 at one end (+10 dB position).

8.12 POTENTIOMETER ADJUSTMENT PROCEDURE

I. LINEARITY ADJUST **(R404)**

a. Set front panel controls to: 1 KHz, 80 HL, Tone Steady, Channel ON.

b. Set a reference on Sound Level Meter (SLM) with either left or right earphone coupled to it.

c. Reduce HL dial to 60 HL and note reading on SLM.

d. Adjust R404 for a -20 dB change from the reference level obtained in step "b".

e. Re-check 80 HL for 20 dB change, readjust R404 as necessary.

II. DISTORTION ADJUST (R403)

NOTE: Tone may be locked "ON" in the Normal Mode by connecting TP100 to the cathode of CR3.

a. Set front panel controls to: 1 KHz, 90 HL (+10 dB activated), Tone Steady, Channel ON.

b. Connect a distortion analyzer to either left or right phone output, load with 60 ohms and select the appropriate output using the front panel switch.

c. Adjust R403 for minimum distortion. Minimum distortion should be less than 2% (THD).

d. Check distortion at opposite earphone jack.

NOTE : If distortion at output cannot be adjusted to less than 2%, remove 60 ohm load and recheck. If distortion reduces, power amplifiers may be at fault, if not, attenuator may be the cause.

8.13 SUGGESTED REPAIR PARTS

1717-4700ROT Audiometer Board Rotating Stock

1717-9610 Parts Kit

Note: The following parts are included in this kit.

Qty	GSI Part Number	Description
3	7874-0173	Slide Switch (Power, L/R, Tone Type)
1	7874-0172	HL Switch
1	7874-0171	Frequency Switch
1	7874-0175	Cal/Norm Switch
1	7874-0170	4 Position Dip Switch
1	5437-1275	LCD
1	1717-3810	LCD Fixture
2	4214-0155	Phone Jacks
1	4204-0147	Earphone Cord
1	1717-9610-AS	1717 LCD Installation Procedure/Parts Kit

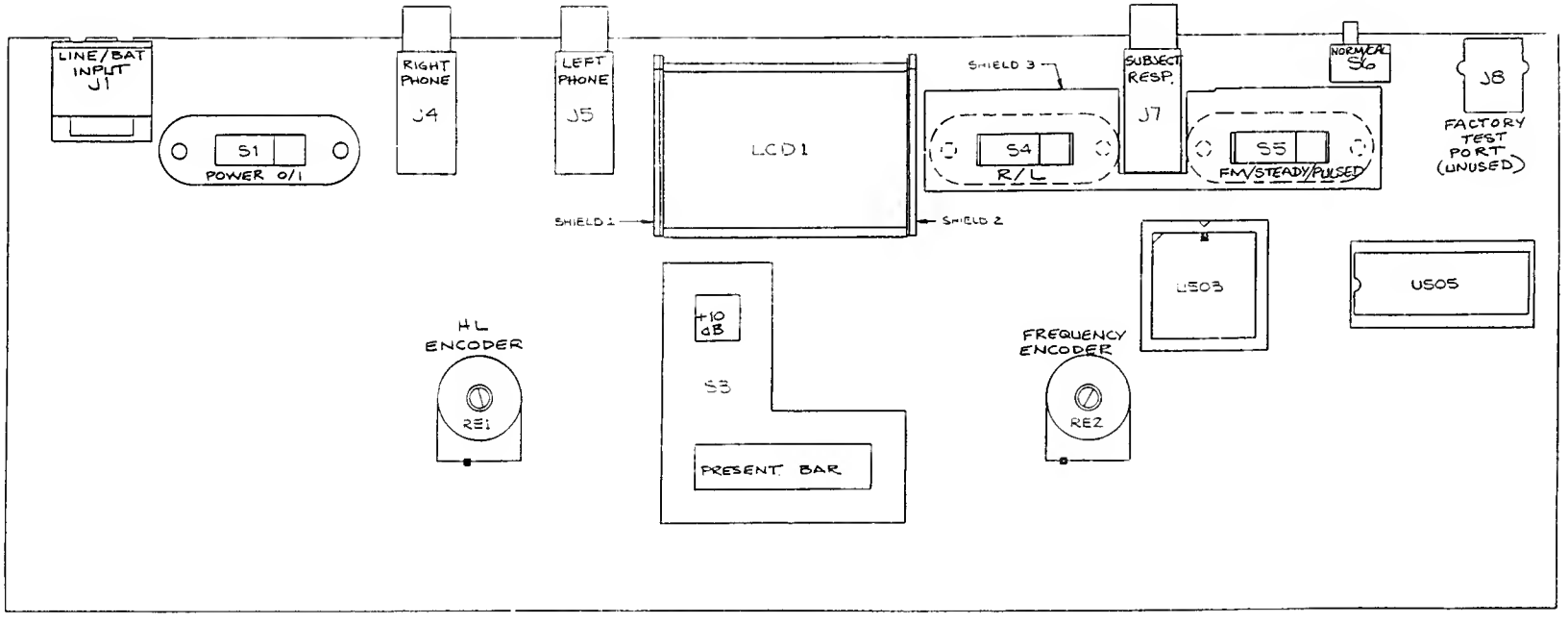
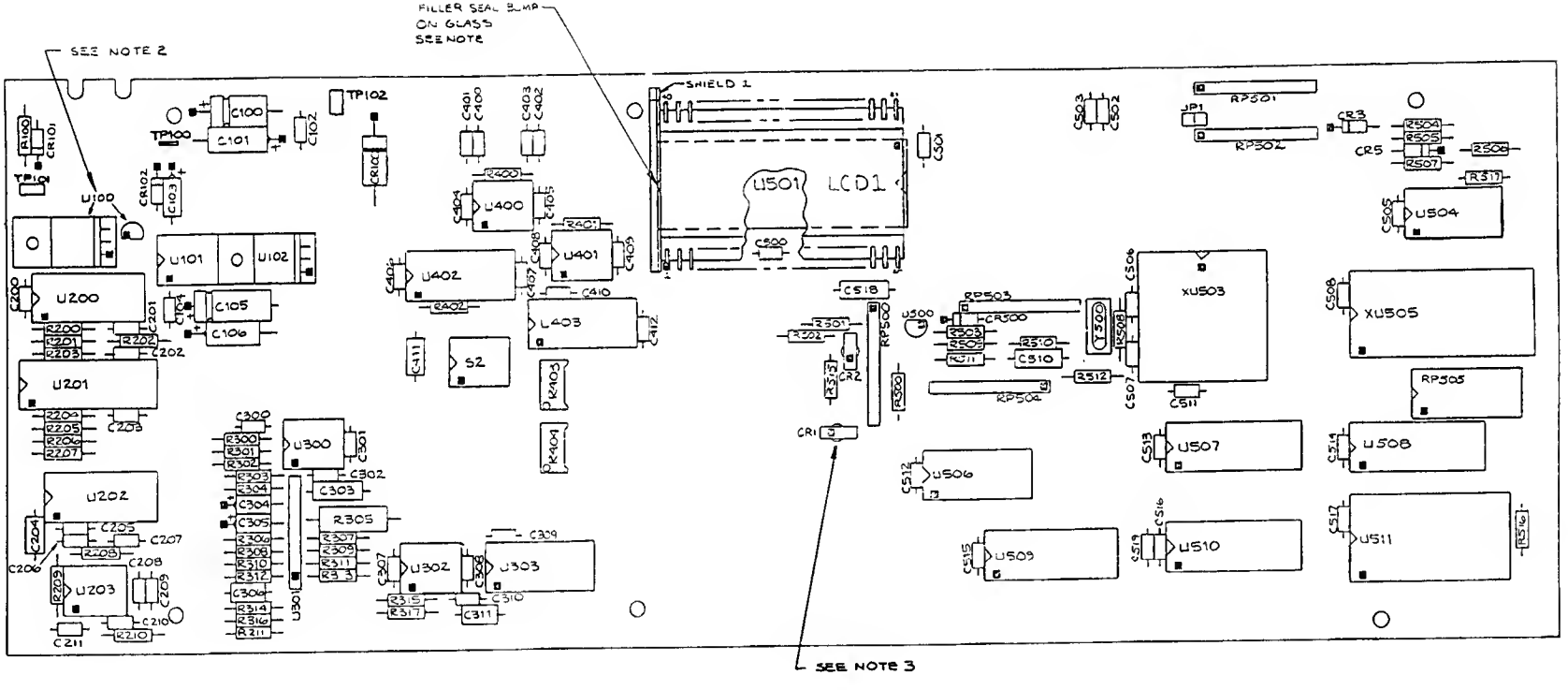


FIGURE 8-1:
AUDIOMETER BD. COMPONENT LAYOUT SHEET #1
1717-4700 (4)



NOTES:

1. INSTALL HEIGHT FIXTURE (1717-3810) UNDER LCD1 WHEN SOLDERING TO BOARD. NOTE PROPER ORIENTATION OF LCD (FILLER SEAL BUMP) BEFORE SOLDERING IN PLACE. HEIGHT FIXTURE WILL REMAIN WITH BOARD THRU SOLDERING, AFTER WHICH IT MAY BE REMOVED AND REUSED.
2. NOTE U100 COMES IN 2 DIFFERENT PACKAGES, BOTH ARE SHOWN BUT ONLY ONE WILL BE INSTALLED.
3. CR1 & CR2 ARE POLARIZED SO THAT THE SHORT LEAD OR (LED FLAG) GOES TO THE SQUARE PAD.

FIGURE 8-1:
AUDIOMETER BD
COMPONENT LA
SHEET #2
1717-4700 (3)

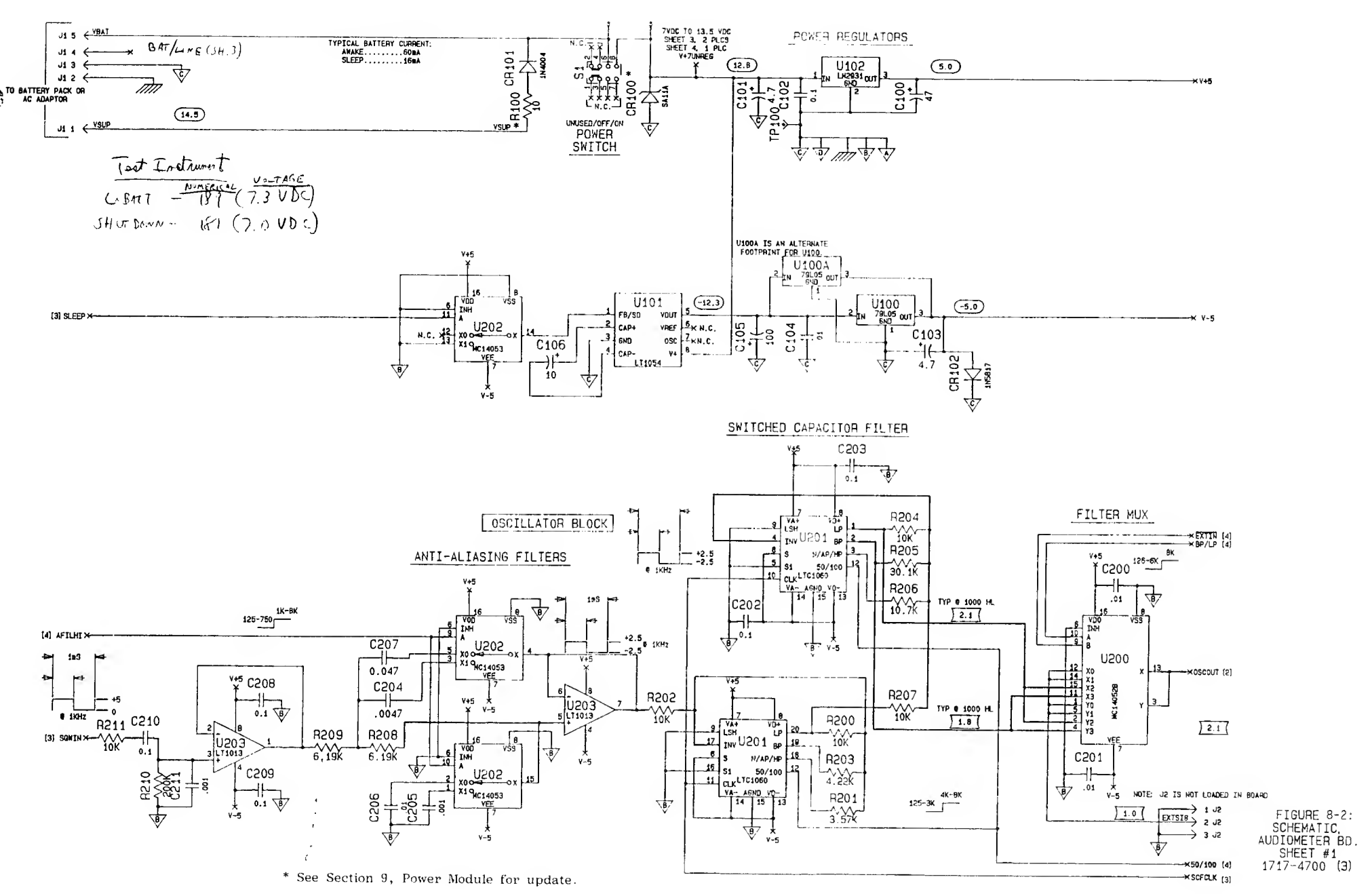


FIGURE 8-2:
SCHEMATIC,
AUDIOMETER BD.
SHEET #1
1717-4700 (3)

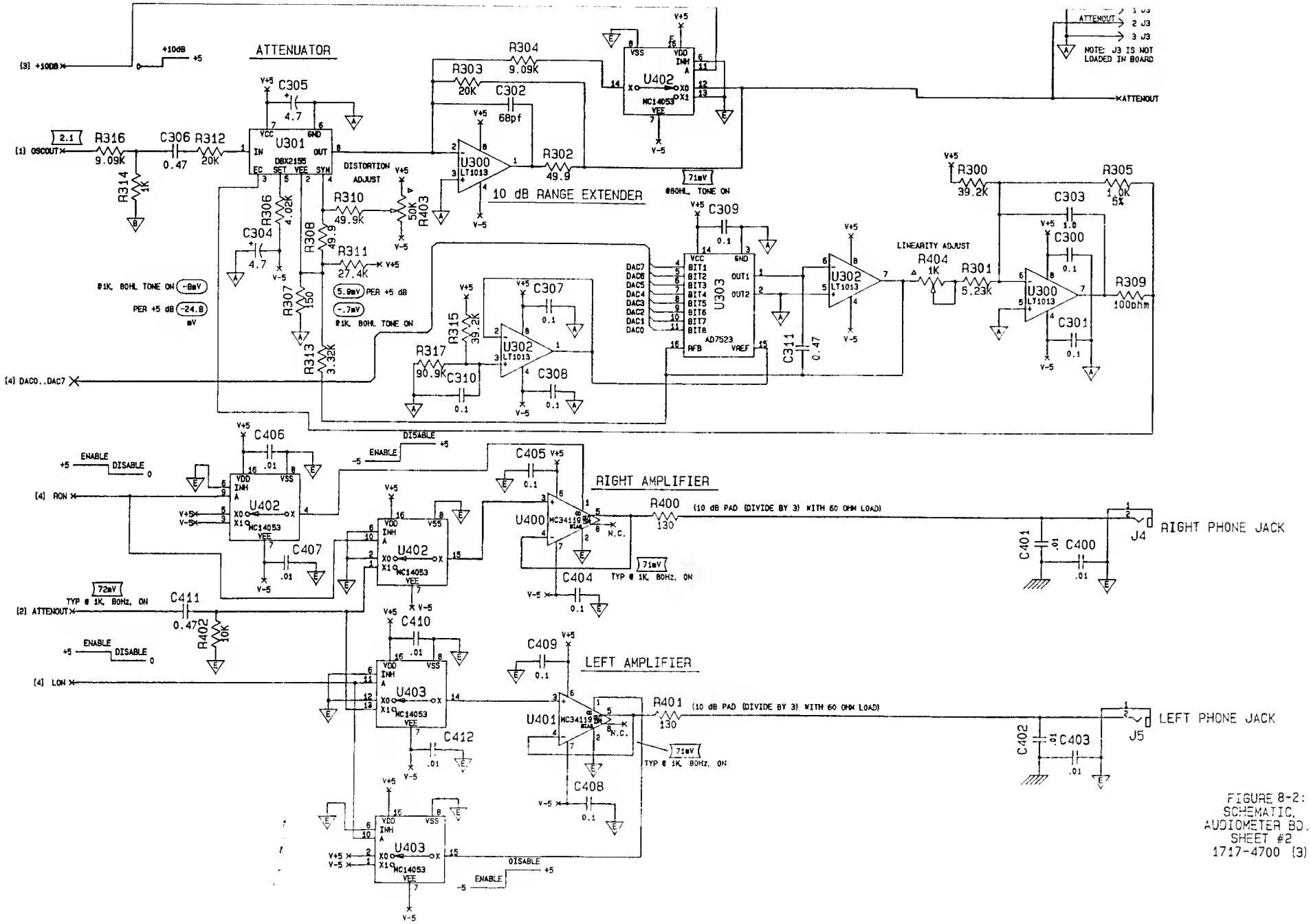


FIGURE 8-2:
SCHEMATIC,
AUDIOMETER BD.,
SHEET #2
1717-4700 (3)

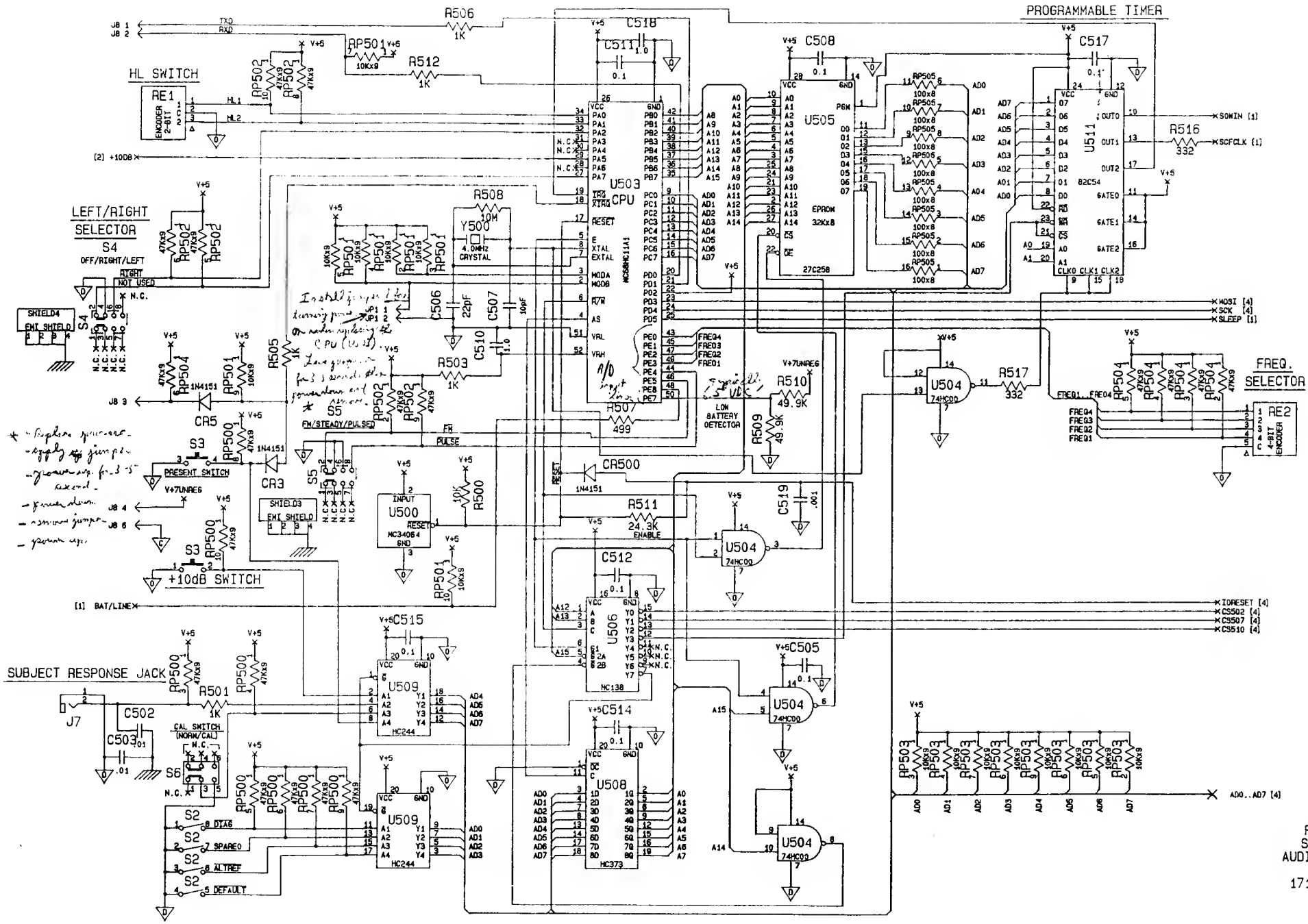
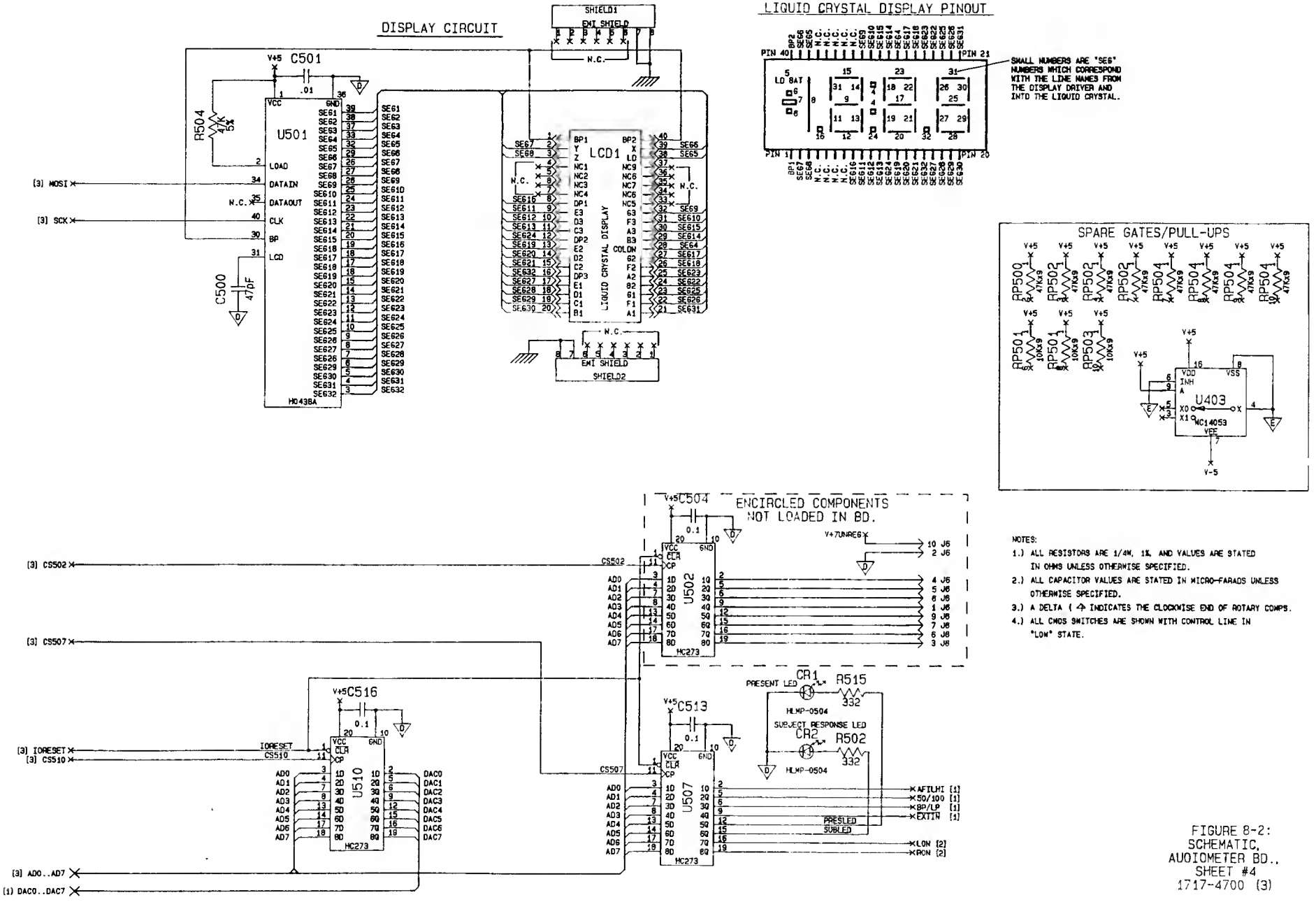


FIGURE 8-2:
SCHEMATIC,
AUDIOMETER BD.,
SHEET #3
1717-4700 (3)



NOTES:

1.) ALL RESISTORS ARE 1/4W, 1% AND VALUES ARE STATED IN OHMS UNLESS OTHERWISE SPECIFIED.

2.) ALL CAPACITOR VALUES ARE STATED IN MICRO-FARADS UNLESS OTHERWISE SPECIFIED.

3.) A DELTA (Δ) INDICATES THE CLOCKWISE END OF ROTARY COMPS.

4.) ALL CMOS SWITCHES ARE SHOWN WITH CONTROL LINE IN "LOW" STATE.

FIGURE 8-2:
SCHEMATIC,
AUDIOMETER BD.,
SHEET #4
1717-4700 (3)

8.14 AUDIOMETER BOARD PARTS LIST 1717-2700 (3)

Ref Designation	Description	Part No.
INTEGRATED CIRCUITS		
U100	IC, Lin., MC79L05, -5V Reg.	5432-1151
U101	IC, LT105A, Volt. Converter/Reg.	5432-1152
U102	IC, Lin., LM2931, +5V Reg.	5432-1150
U200	IC, MC14052B, Dual Chan. Mltplx.	5431-7027
U201	IC, MF10, Dual Filter	5432-1091
U202	IC, MC14053B, Tri 2 Chan. Mux/Demux	5431-7054
U203	IC, LT1013, Dual Op. Amp.	5432-1050
U300	See U203	
U301	IC, DBX2155, VC Amp.	5432-1092
U302	See U203	
U303	IC, AD7523, 8 Bit D/A Conv.	5432-7003
U400 and U401	IC, MC34119, Low Pwr. Audio. Amp.	5432-1120
U402 and U403	See U202	
U500	IC, MC34064, Undervoltage Sensor	5432-1117
U501	IC, H0438A, Serial LCD Driver	5433-1020
U503	IC, MC68HC11A1, 8 Bit MicroContr.	5431-9017
U504	IC, 74HC00, Quad. 2 Input Nand.	5431-3000
U506	IC, 74HC138, 1 of 8 Decode/Demux	5431-3138
U507	IC, 74HC273, Octal D Flip Flop	5431-3273
U508	IC, 74HC373, Tri State Octal Latch	5431-3373
U509	IC, 74HC244, Octal Buffer/Driver	5431-3244
U510	See U507	
U511	IC, 82C54, Prog. Timer	5431-9012
DIODES		
CR1 and CR2	LED, HLMP-0504, Green, Square	6084-1206
CR3	Diode, 1N4151	6082-1001
CR5	See CR3	
CR100*	Diode, Zener, SA11A	6083-1100
CR101	Diode, 1N4004	6081-1002
CR102	Diode, 1N5817	6084-1017
CR500	See CR3	
RESISTORS AND POTENTIOMETERS		
R100*	Res., Film, 10 Ohm, 1/4W, 1%	6350-9100
R200	Res., Film, 10K, 1/4W, 1%	6350-2100
R201	Res., Film, 3.57K, 1/4W, 1%	6350-1357
R202	See R200	
R203	Res., Film, 4.22K, 1/4W, 1%	6350-1422
R204	See R200	
R205	Res., Film, 30.1K, 1/4W, 1%	6350-2301
R206	Res., Film, 10.7K, 1/4W, 1%	6350-2107
R207	See R200	
R208 and R209	Res., Film, 6.19K, 1/4W, 1%	6350-1619
R210	Res., Film, 200K, 1/4W, 1%	6350-3200
R211	See R200	
R300	Res., Film, 39.2K, 1/4W, 1%	**6350-2392**

*See Section 9, Power Module for update.

Ref. Designation	Description	Part No.
RESISTORS AND POTENTIOMETERS		
R301	Res., Film, 5.23K, 1/4W, 1%	6350-1523
R302	Res., Film, 49.9 Ohm, 1/4W, 1%	6350-9499
R303	Res., Film, 20K, 1/4W, 1%	6350-2200
R304	Res., Film, 9.09K, 1/4W, 1%	6350-1909
R305	Res., Film, 3930 PPM, 1.0K, 5%	6700-0002
R306	Res., Film, 4.02K 1/4W, 1%	6350-1402
R307	Res., Film, 150 Ohm, 1/4W, 1%	6350-0150
R308	See R302	
R309	Res., Film, 100 Ohm, 1/4W, 1%	6350-0100
R310	Res., Film, 49.9K, 1/4W, 1%	6350-2499
R311	Res., Film, 27.4K, 1/4W, 1%	6350-2274
R312	See R303	
R313	Res., Film, 3.32K, 1/4W, 1%	6350-1332
R314	Res., Film, 1K, 1/4W, 1%	6350-1100
R315	See R300	
R316	See R304	
R317	Res., Film, 90.9K, 1/4W, 1 5	**6350-2909**
R400 and R401	Res., Film, 130 Ohm, 1/4W, 1%	6350-0130
R402	See R200	
R403	Pot., Comp., 50K, 20%, 25 Turn	**6049-0350**
R404	Pot., Comp., 1K, 10%, 25 Turn	**6049-0500**
R500	See R200	
R501	See R314	
R502	Res., Film, 332 Ohm, 1/4W, 1%	6350-0332
R503	See R314	
R504	Res., Comp., 47K, 5%	
R505 and R506	See R314	
R507	Res., Film, 499 Ohm, 1/4W, 1%	**6350-0499**
R508	Res., Comp., 10M, 1/4W, 1%	6099-6105
R509 and R510	See R310	
R511	Res., Film, 24.3K, 1/4W, 1%	6350-2243
R512	See R314	
R515 thru R517	See R502	
RPSOO	Res., Network, 47K x 9, ±2%	6740-1747
RP501	Res., Network, 10K x 9, ±2%	6740-1712
RP502	See RPSOO	
RP503	See RP501	
RP504	See RPSOO	
RP505	Res., Network, 100K x 8, ±2%	6740-1710
CAPACITORS		
C100	Cap., Tant., 47 uF 20%, 16V	4450-4520
C101	Cap., Tant., 4.7 uF, 20%, 50V	4450-4990
C102	Cap., Cer., 0.1 uF, 20%, 50V	4400-3000
C103	Cap., Elect., 4.7 uF, 208, 10V	4450-4700
C104	Cap., Cer., .01 uF, -20%, +80%, 50V	4400-3003
C105	Cap., Tant., 100 uF, 16V	4450-4515
C106	Cap., Tant., 10 uF, 208, 6v	4450-5100
C200 and C201	See C104	

Ref. Designation	Description	Part No.
CAPACITORS		
C202 and C203	See C102	
C204	Cap., Cer., .0047 Uf, 5%, 50V	4400-3010
C205	Cap., Cer., .001 uF, 5%, 50V	4400-3008
C206	Cap., Cer., .01 uF, 20%, 50v	4400-3004
C207	Cap., Cer., 0.047 uF, 5%, 50V	4400-3009
C208 thru C210	See C102	
C211	See C205	
C300 and C301	See C102	
C302	Cap., Cer., 68 pF, 10%, 100V	4400-3007
C303	Cap., Cer., 1.0 uF, +20%, -80%, 50V	4400-3002
C304 and C305	See C103	
C306	Cap., Cer., 0.47 uF, -20% +80%, 5ov	4400-3001
C307 thru C310	See C102	
C311	See C306	
C400 thru C403	See C104	
C404 and C405	See C102	
C406 and C407	See C104	
C408 and C409	See C102	
C410	See C104	
C411	See C306	
C412	See C104	
C500	Cap., Cer., 47 pF, 10%, 100V	4400-3006
C501 thru C503	See C104	
C505	See C102	
C506	Cap., Cer., 22 pF, 10%, 100V	4400-2022
C507	Cap., Cer., 10 pF, 10%, 100V	4400-3005
C508	See C102	
C510	See C1303	
C511 thru C517	See C102	
C518	See C303	
c519	See C205	
IC SOCKETS		
XU503	Socket, IC, 28 Contact	7540-1828
XU505	Socket, PLCC., 52 Contact	7540-1852
MISCELLANEOUS		
J1	Conn., Pow. Input, 5 Pin, Din Socket	4230-4025
J4 and J5	Jack, Earphone & Handswitch, PC Mtg.	4214-0155
J7	See J4	
J8	Conn., 6 Pin, Female, Telephone	4230-4030
LCD1	Display, LCD, 3.5 Digit	5437-1275
RE1	HL Encoder, 2-Bit Rotary	7874-0172
RE2	Frequency Encoder, 4-Bit Rotary	7874-0171
s2	Switch Dip, 4 Position	7874-0170
s3	Switch, Present/Ext. Range Switch	1717-0400
S6	Switch, Cal/Norm, DPDT, Rt. Angle	7874-0175

Ref. Desisnation	Description	Part No.
MISCELLANEOUS		
SHIELD 1	ESD Director, LCD, .83" H.	1717-8005
SHIELD 2	ESD Director, LCD, 0.83" H.	1717-8005
SHIELD 3	ESD Shield, Switch, .45" H.	1717-8010
TP100 thru TP102	Jumper, Test Point	5080-0001
U505	EPROM, Programmed	1717-0500
Y500	Crystal, 4 MHz, Low Profile	5075-0045
DBL Pole, 3 Pos.	Switch, Slide (ON/OFF, L/R, FM/ Steady/Pulse)	7874-0173
	Spacer, LED	7574-0205
	Insulator, Crystal	7574-0210

SECTION 9

Power Module

9.1 UPDATE

The introduction of a new instrument (the GSI 37 Auto Tymp) to our product line dictated that we stock a larger capacity power module than the one used in this instrument. Rather than stock two power modules, the decision was made to change the GSI 17 module to the larger capacity module required for the GSI 37. The new larger capacity modules can be used on a GSI 17 with the serial number 0856 and higher. Therefore, before replacing power modules, please check the instrument serial number and refer to the following information for part numbers.

9.2 FOR SPECIFIC SERIAL NUMBER

GSI 17's with a serial number less than 0856

We have reserved a quantity of the lower capacity power module, so that GSI 17's with serial numbers less than 0856 do not need circuitry modification. The following part numbers apply to these "reserved" power modules.

Mains Voltage	Plug Configuration	New Part Number
120 VAC	USA	8000-0220SVC
220 VAC	Euro-Plug	8000-0221SVC
240 VAC	UK-Plug	8000-0222SVC
220 VAC	Generic	8000-0250

GSI 17's with a serial number 0856 and higher

To incorporate this new power module, a diode (CR100) and a resistor (R100) had to be changed on the GSI 17 board. Following are the component changes:

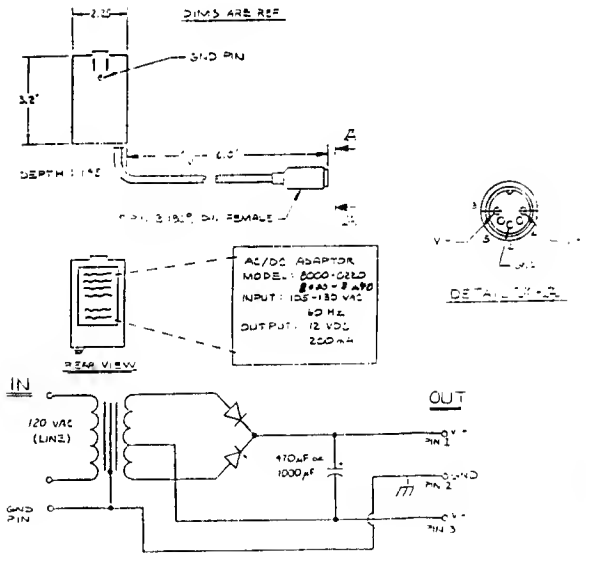
CR100 - was a 1 watt package (GSI #6083-1100, MFG #SA11A) and is now a 5 watt package (GSI #6083-1040, MFG #P6KE13A)

R100 - was a 1/4 watt 10Ω resistor (GSI #6350-9100) and is now a 1/2 watt 27Ω resistor (GSI #6100-0275)

The following part numbers apply to the new power module and can only be used with serial numbers 0856 and higher.

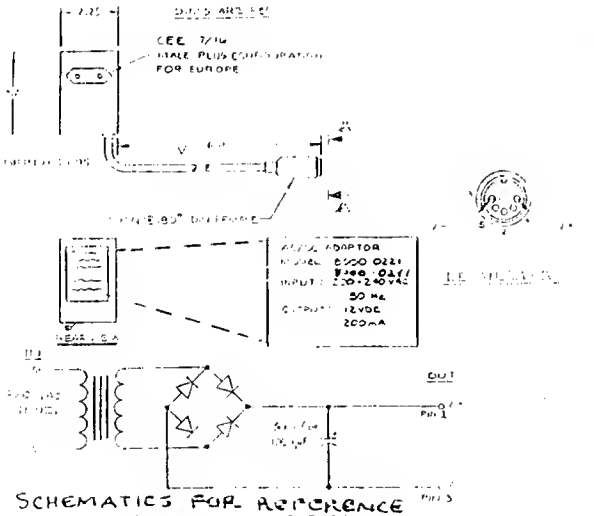
Mains Voltage	Plug Configuration	New Part Number
120 VAC	USA	8000-0240
220 VAC	Euro-Plug	8000-0241
240 VAC	UK-Plug	8000-0242
220 VAC	Generic	8000-0250

PART NUMBER
8000-0220 USA
OR
8000-0240

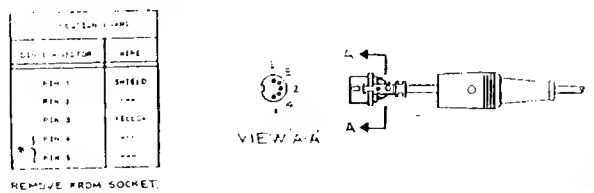


SCHEMATIC FOR REFERENCE ONLY
MODULES CANNOT BE REPAIRED

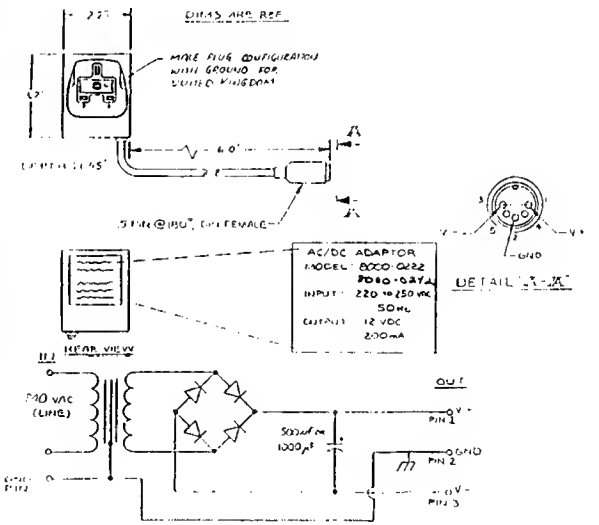
PART NUMBER
8000-0221 → EUROPE
OR
8000-0241



SCHEMATICS FOR REFERENCE
ONLY. MODULES CANNOT BE REPAIRED.



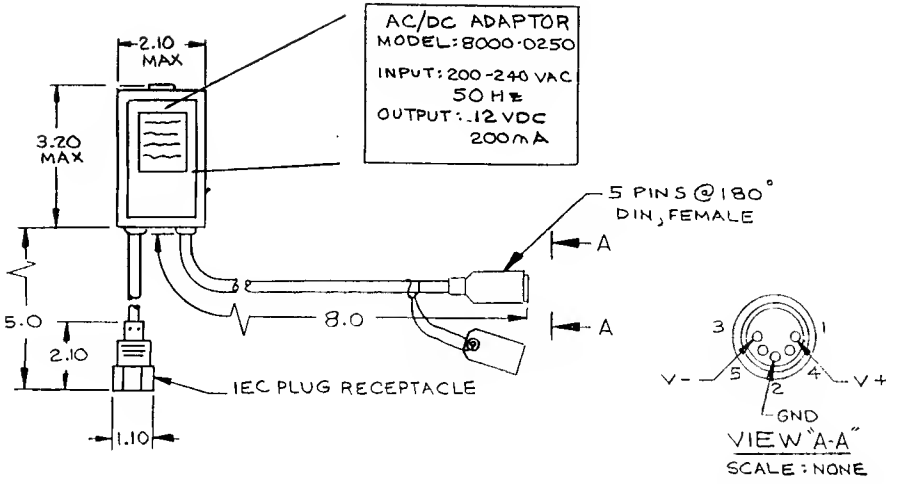
PART NUMBER
8000-0222 — UNITED KINGDOM
OR
8000-0242

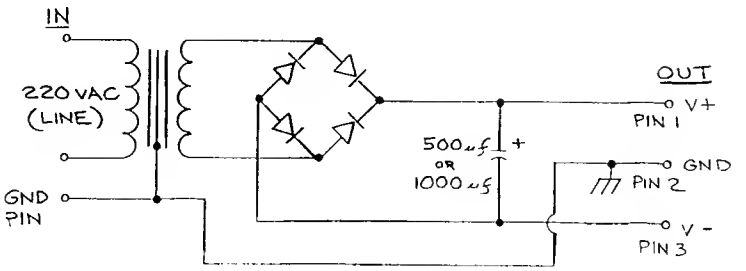


SCHEMATIC FOR REFERENCE ONLY
MODULES CANNOT BE REPAIRED

FIGURE 9-1:
POWER MODULE
SCHEMATIC

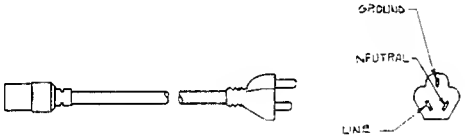
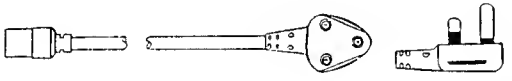
POWER MODULE PART NUMBER 8000-0250 (GENERIC)





- REFERENCE ONLY -
MODULES CANNOT BE REPAIRED

POWER CORD CONFIGURATIONS AND REFERENCE OF COUNTRIES KNOWN TO REQUIRE THIS AC (MAINS) CONFIGURATION:

PART NUMBER	REFERENCE COUNTRY	PICTORIAL/CONFIGURATION
4204-0273	AUSTRALIA	
4204-0274	ITALY	
4204-0277	SOUTH AFRICA	
4204-0278	ISRAEL	

PART NUMBERS FOR COMBINATION POWER MODULE AND POWER CORD.

1717-2073	AUSTRALIA
1717-2074	ITALY
1717-2077	SOUTH AFRICA
1717-2078	ISRAEL

FIGURE 9-2:
POWER MODULE/CORDS

SECTION 10

Battery Option

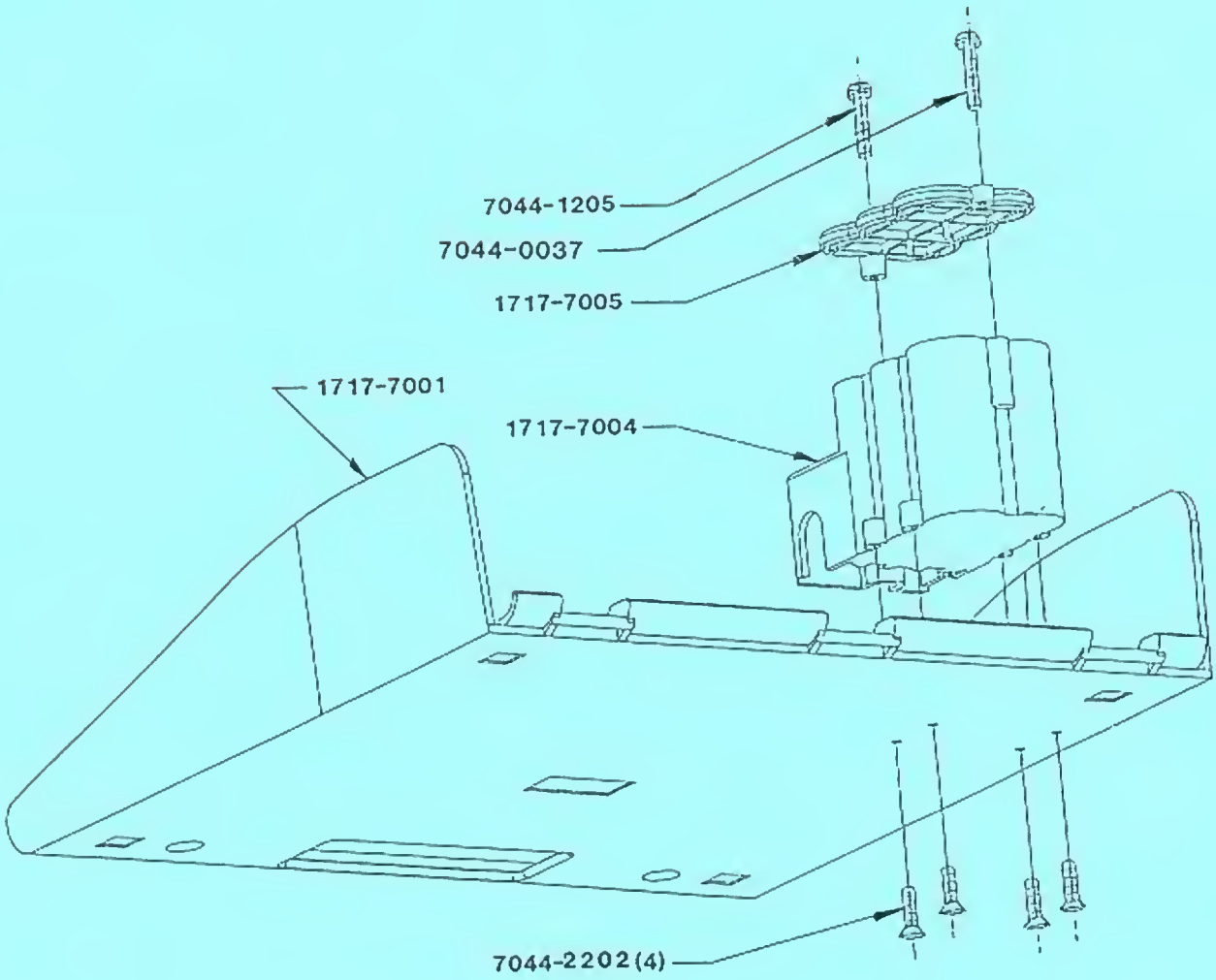


Figure 10-1: BATTERY PACK INSTALLATION

10.1 DESCRIPTION

The GSI 17 can be operated via battery power with the 1717-2010 battery option. This battery pack can be used with the GSI-supplied rechargeable NiCad pack (8410-0060) or with commercially available size C alkaline batteries. (See Figure 10-3 for an illustration of the battery pack).

NOTE:

In no instance will loss of battery power affect instrument calibration.

10.2 BATTERY PACK INSTALLATION

If your audiometer was purchased with the battery option, the pack is already installed in the instrument and you can disregard this section.

If the GSI 17 battery pack has been purchased separately from the audiometer, it must be installed into the instrument. Note that there are four (4) screws included with your battery pack option. They will be used to mount the pack into the storage cavity of the audiometer. On the bottom of the storage cavity, located close to one side, are four (4) indentations. These are thin sections of the case which must be punctured to provide entry holes for the four screws. (See Figure 10-1).

Before installing the battery pack, be sure the instrument is turned off and unplugged from the AC power (mains) outlet. Unplug the power cord, the earphone jacks and the handswitch (if used) from the back panel of the audiometer. Remove these items from the instrument. For greatest convenience, remove the top cover and place the instrument on a flat surface. Proceed as follows:

a. Using a Phillips head screw driver, gently apply pressure to the four indentations, one at a time, to puncture the case for the screw entry holes. Turning the screw driver will help achieve the correct hole size.

b. Turn the instrument on its side. To attach the battery pack, you will need to hold it in the storage cavity while inserting the mounting screws. Secure all four screws.

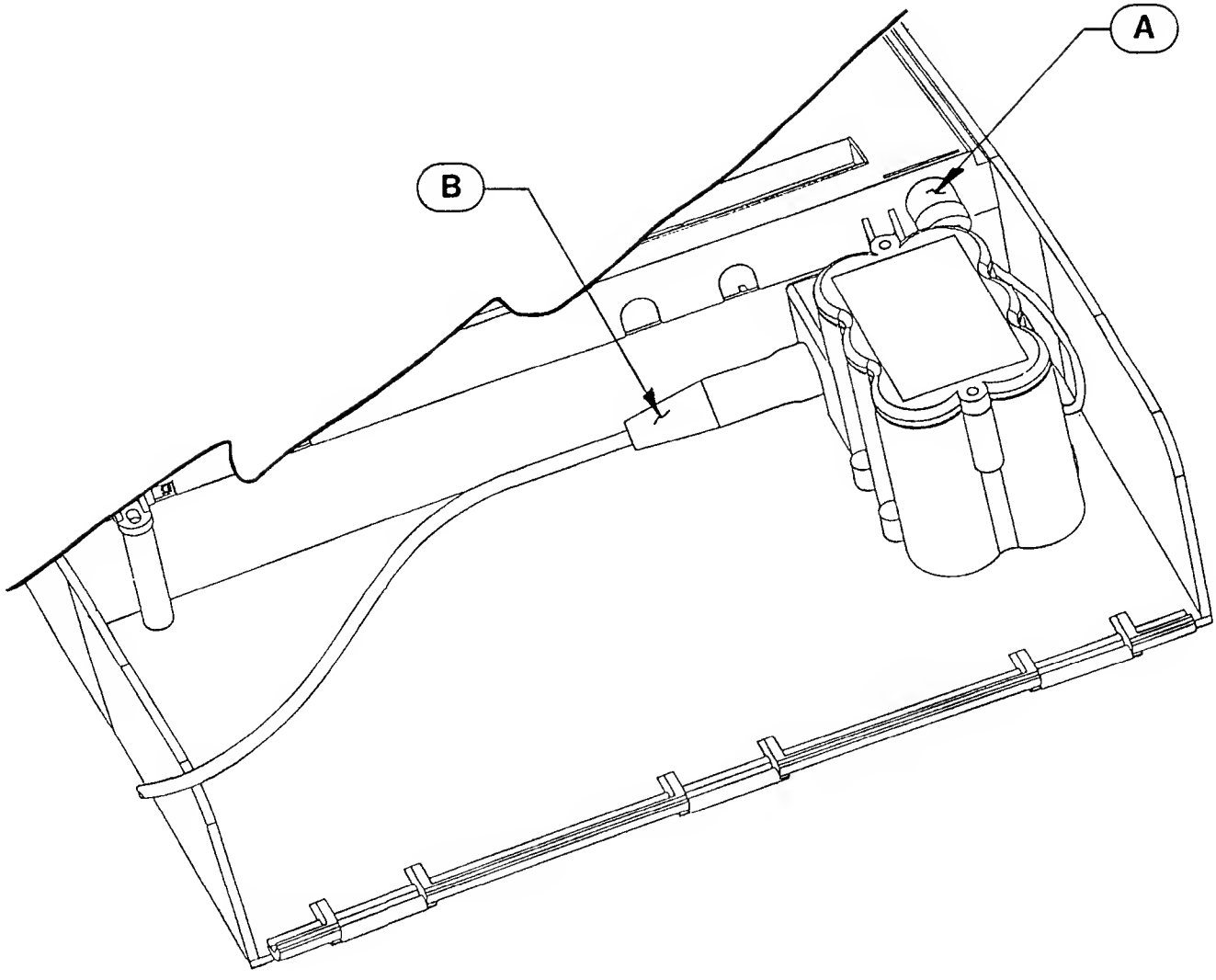


Figure 10-2: BATTERY POWER CONNECTION

c. Connect the battery pack power cord (A) to the power cord receptacle on the rear panel of the audiometer. For line power operation (mains) or recharging, connect the instrument power cord (B) to the receptacle on the lower edge of the battery pack (perpendicular to the instrument rear panel). (See Figure 10-2).

10.3 NiCad BATTERY OPERATION

The GSI 17 battery option is supplied with an installed, rechargeable NiCad battery pack. It requires about 18 hours to fully charge, and will provide about 22 hours of continuous operation. The green LED on the pack itself will be lit when charging is in progress. The words LO BAT will be illuminated on the front panel LCD when the battery charge is getting low so the operator will know when to recharge the batteries. When LO BAT is lit, the instrument will operate (continuously) for about two hours before it shuts down completely.

NOTE:

In no instance will loss of battery power affect instrument calibration.

CAUTION:

Although no damage to the rechargeable NiCad batteries will occur if the pack is left charging for more than the 18 hours required for a full charge, the batteries should not be left charging for extended periods (i.e. several days) because the useful life of the rechargeable NiCad pack will be shortened. Lucas GSI recommends unplugging the battery pack power input cord from the rear of the audiometer and plugging the main line power cord into this jack if main line power is to be used most of the time.

To save battery life, the GSI 17 has a special "Sleep Mode" in which the audiometer will shut down after 5 minutes of no operation. The operator will know the instrument is "asleep" because the LCD will show three dash lines (- - -). To "wake up" the instrument the operator only needs to press the Present Bar. There is no danger of presenting a loud tone to the test subject when the instrument "wakes up" because no tone is presented until the audiometer is awake. In addition, the instrument automatically resets its output to 0 dBHL.

If the GSI 17 is operated until the battery charge has dropped below an acceptable voltage level, the instrument will not function at all. The display will be blank except for the LO BAT

indication, and the controls will not function. To restore operation, the batteries must be recharged for up to 18 hours (full charge), or AC power (mains) may be used.

If the audiometer is operated via AC power (mains) with the rechargeable batteries in place, some battery charging will occur.

10.4 ALKALINE BATTERY INSTALLATION/OPERATION

For longer, continuous battery operation, such as periods when recharging on a regular basis is not possible, the rechargeable batteries can be replaced with six size C alkaline batteries. These batteries will provide about 45 hours of continuous operation.

The low voltage indicator works the same way for the alkaline batteries as it does for the NiCad batteries, that is, the words LO BAT will be lit on the LCD when there are about 6 hours of continuous battery operation available. In addition, the "sleep mode" also works with the alkaline batteries to prolong their useful life.

Before installing the alkaline batteries, unplug the GSI 17 from the line power (mains). To install the alkaline batteries, first remove the battery pack cover by removing the two screws that hold it in place, then lift off the cover. Carefully pull the NiCad batteries out of the pack (they are wrapped in plastic and will come out of the pack as a single unit). Carefully disconnect the lead wires of the NiCad batteries from the battery compartment by disconnecting the small plug connector. You will notice six spring mounts on the top and bottom of the battery compartment. These are for the alkaline batteries. (See Figure 10-3 for a pictorial diagram of NiCad removal).

Before inserting the alkaline batteries into the pack, check the label on the bottom surface of the compartment which indicates the correct polarity (orientation) of the batteries. Put the six batteries in, one at a time, matching the polarity (+ or -) with the label. Replace the battery pack cover being sure it is positioned with the spring mounts touching the batteries. There is only one way the cover fits correctly so that the screws are secure.

NOTE:

If alkaline batteries are not going to be used on a regular basis, they should not be stored in the audiometer. They should be removed from the battery pack and stored in a cool, dry place.

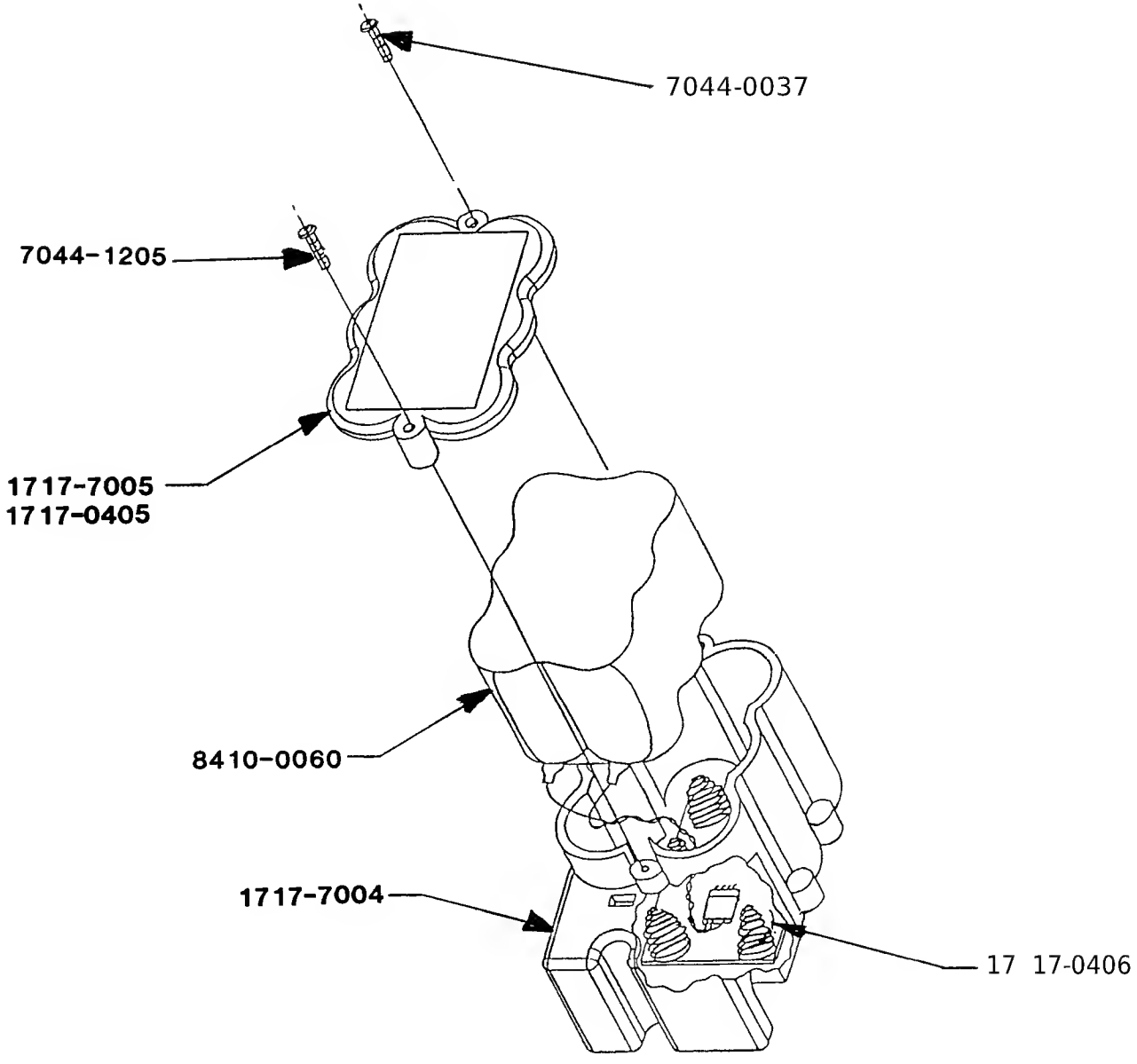


Figure 10-3: NiCad BATTERY OPERATION

10.5 NiCad BATTERY ASSEMBLY PARTS LIST 1717-2010

Description	Part No.
Base, Battery	1717-7004
Cover, Battery	1717-7005
Label, Battery Compartment	1717-0442
Assembly, Battery Charge Board	1717-4710
Screw, Locking 6-32 x .375 lg.	7044-0037
Screw, Pan Hd., 6-32 x .750 lg.	7044-1205
Battery Pack, GSI 17, NiCad	8410-0060
Assembly, Battery Contact Board, Top (Not Replaceable - Swaged)	1717-0405
Assembly, NiCad Conn., Battery Contact Board (Not Replaceable - Swaged)	1717-2015

10.6 BATTERY BOARD FUNCTIONAL DESCRIPTION

The Battery Charger Board serves several purposes. When connected to the GSI 17 the charger board relay connects the battery voltage to the GSI 17 power input. When a power module is connected to the Battery Charger Board the applied voltage energizes the relay which connects the charger board regulated voltage to the GSI 17 power input. The charger board voltage regulator U1 (LM2931) is capable of sourcing 150 ma which is used to power the GSI 17 and charge the NiCad Battery if installed. A resistive divider network on the board enables the GSI 17 A/D converter to determine if the GSI 17 is being powered by battery or via the power module.

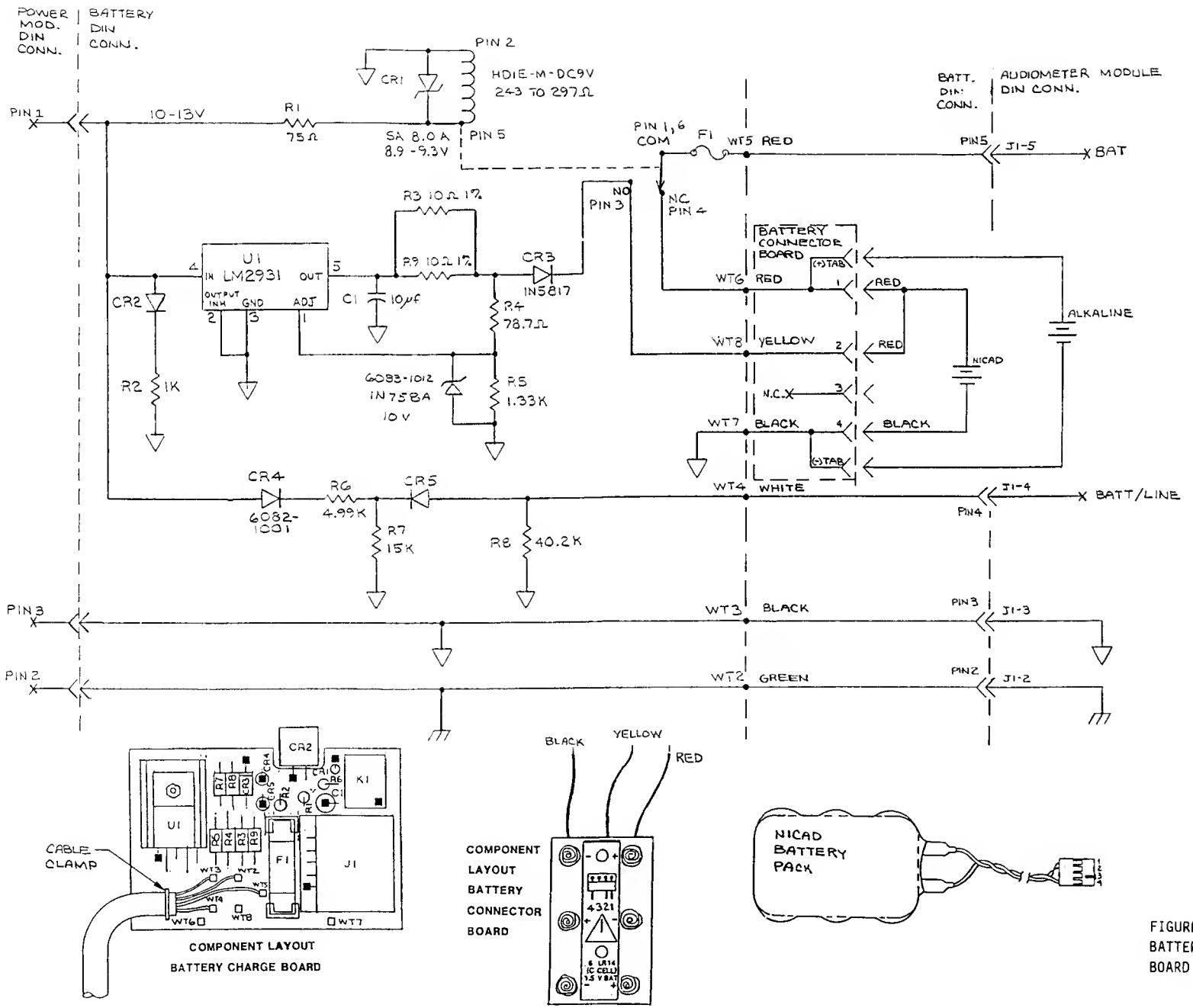


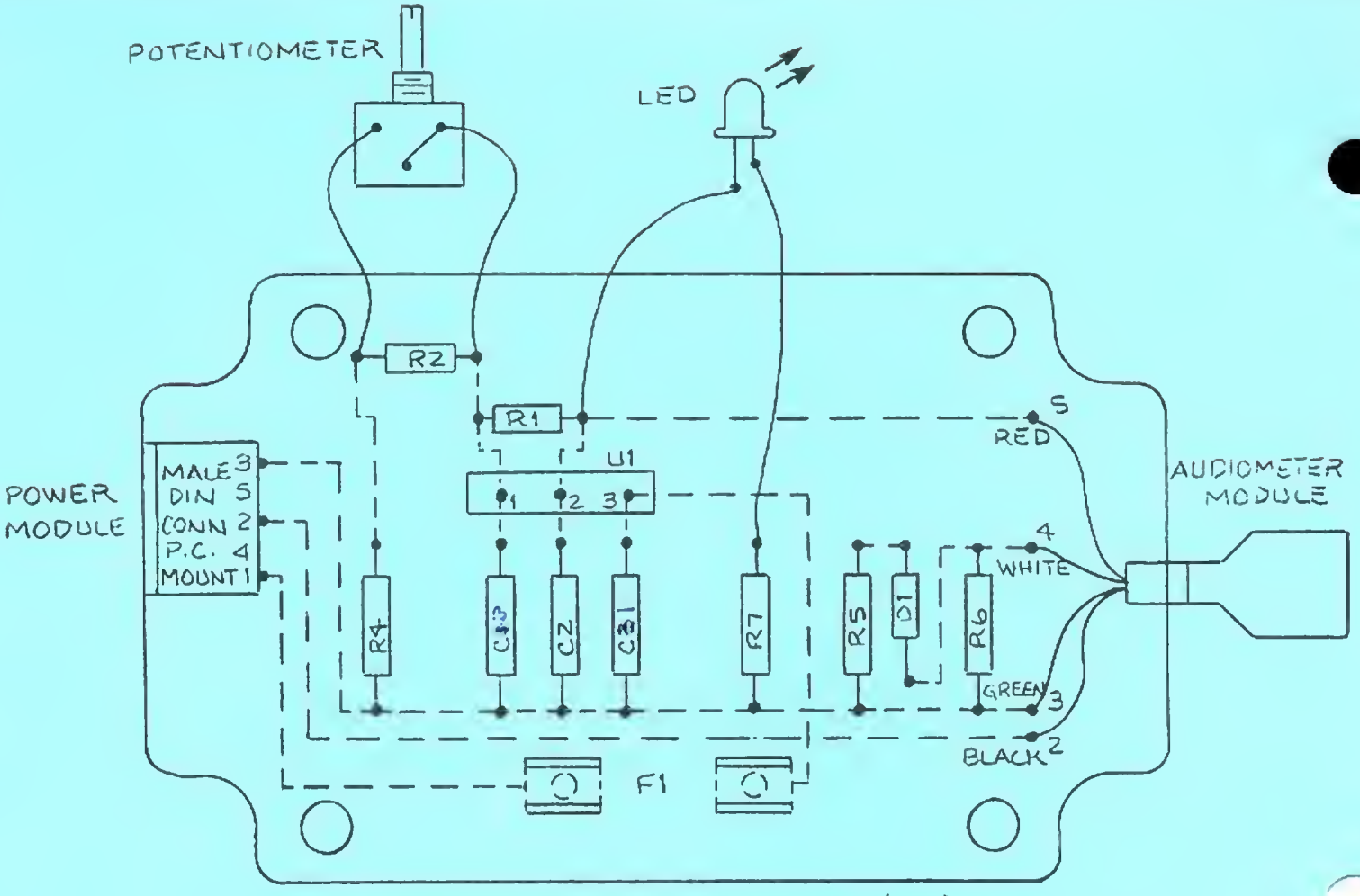
FIGURE 10-4:
BATTERY CHARGER
BOARD SCHEMATIC

10.7 BATTERY/CHARGE BOARD PARTS LIST 1717-4710

Ref. Desiqnation	Description	Part No.
INTEGRATED CIRCUIT		
U1	IC, Lin, LM2931, Adj., Reg.	5432-1153
DIODES		
CR1	Diode, Zener, 8.9V - 9.3V	6083-1101
CR2	LED, HLMP-0504, Green, Square	6084-1206
CR3	Diode, 1N5817, 60V	6084-1017
CR4 and CR5	Diode, 1N4151	6082-1001
	Diode, Zener, 1N758A, 10V	6083-1012
RESISTORS		
R1	Res., Comp., 75 Ohm, .50W, 5%	6100-0755
R2	Res., Film, 1K, .25W, 1%	6350-1100
R3	Res., Film, 10 Ohm, .25W 1%	6350-9100
R4	Res., Film, 78.7 Ohm, 25W 1%	6350-9787
R5	Res., Film, 1.33K, 25W, 1%	6350-1133
R6	Res., Film, 4.99K, 25W 1%	6350-1499
R7	Res., Film, 15K, .25W, 1%	6350-2150
R8	Res., Film, 40.2K, .25W 1%	6350-2402
R9	See R3	
CAPACITOR		
C1	Cap., Tant., 10 uF, 20V, 20%	4450-5100
FUSE		
F1	Fuse, 0.63 Amp, SLO-BLO	5330-1100
RELAY		
K1	Relay, Spdt., 9V	6090-1530
MISCELLANEOUS		
J1	Conn., 5 Pin Din, Male	4230-4025
	Assembly, Cable, Battery	1717-2020
	Clamp, Insulated, 4"	4314-0030
	Heat Sink, Low-Profile	5415-1070
	Clip, Fuse	5650-0200
	Nut, #4-40	5814-0001
	Screw, Pan Hd., #4-40, 0.375" lg.	7044-1103

APPENDIX A

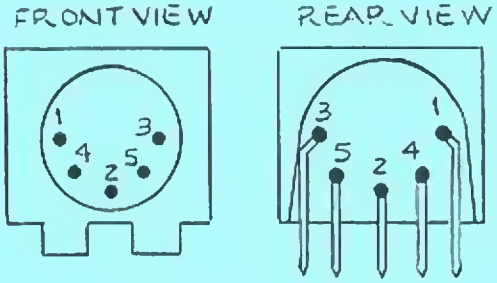
Test Circuit



COMPONENT LAYOUT (2X)

EXAMPLE OF COMPONENT LAYOUT WHICH MAY BE USED WITH A RADIO SHACK MODEL # 270-283 PROJECT BOX WITH P.C. BOARD OR EQUIVALENT.

MALE DIN CONNECTOR



DIN PLUG
BATTERY CABLE ASSEMBLY

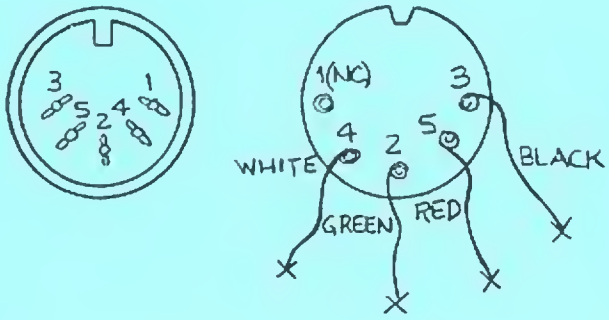
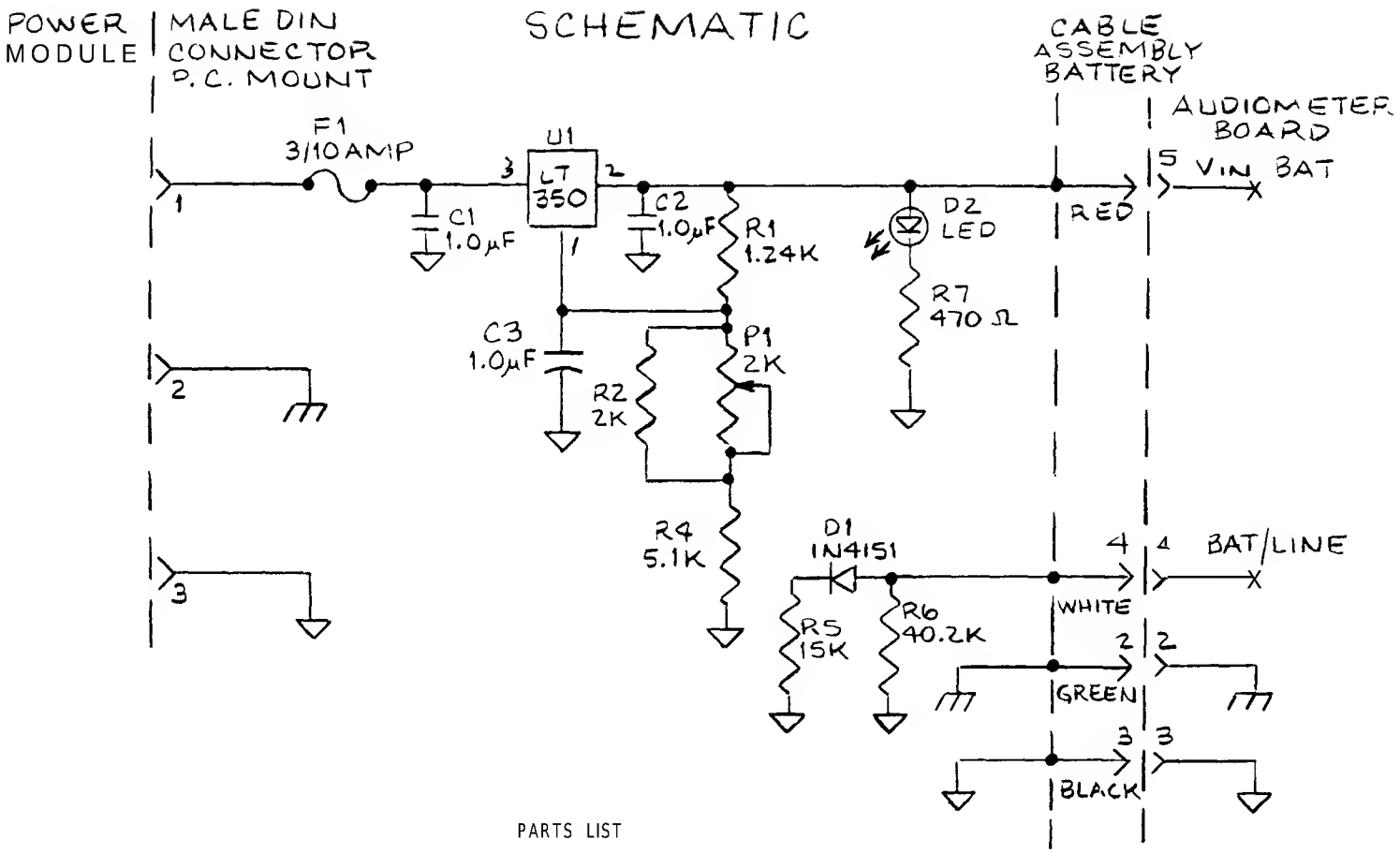


FIGURE A-1:
COMPONENT LAYOUT
TEST CIRCUIT
BATTERY LOW/SHUTDOWN CALIBRATION



PARTS LIST

REFERENCE	QUANTITY	DESCRIPTION	PART NUMBER
F1	1	FUSE, 3/10 AMP	5330-0800
U1	1	LT350, REGULATOR, ADJ.	5433-1021
D1	1	DIODE, IN4151	6082-1001
C1, C2, C3	3	CAP, 1 uf, 35 v, 10%	4450-4301
R1	1	RESISTOR, 1.24 K ohm	6350-1124
R2	1	RESISTOR, 2 K ohm	5099-2205
R4	1	RESISTOR, 5.11 K ohm	6350-1511
R5	1	RESISTOR, 15 K ohm	6350-2150
R6	1	RESISTOR, 40.2 K ohm	6350-2402
R7	1	RESISTOR, 470 ohm	6099-1475
	*1	CABLE ASSEMBLY BATTERY	1717-2020
	1	POWER MODULE (1 17 V)	8000-0220
		BREAD BOARD	4260-1360
	1	CONNECTOR, MALE DIN, P.C. MOUNT	4230-4025
	2	CLIP, FUSE HOLDER	5640-1800
	2	NUT, HEX, LOCKING, #4-40	5814-0001
	2	SCREW, PAN HEAD, #4-40 x 3/8"	7044-1103
	1	KNOB	5504-0080
	1	LED (with mounting hardware)	6084-1050
P1	1	POTENTIOMETER 2 K ohm	6004-0090
		RADIO SHACK, MODEL #270-283 PROJECT BOX or equiv	
	*consisting of:	CABLE, 4 COND. #22 (specify length)	0035-6700
		CONNECTOR, 5 PIN DIN, FEHALE	4230-8080
		TUBING, SHRINK, 2" LONG	0028-0187

FIGURE A-2:
SCHEMATIC & PARTS LIST
TEST CIRCUIT
BATTERY LOW/SHUTDOWN CALIBRATION